Workshop Service Manual

MASSEY FERGUSON

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MF 65 TRACTOR SERVICE MANUAL

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PART 2. FRONT AXLE ASSEMBLIES MF 50 AND 65 TRACTORS

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SERVICING MF 50 & 65 MULTI-PURPOSE, STANDARD, HI-ARCH, AND UTILITY FRONT AXLE ASSEMBLIES

Similiarities between front axle assemblies of the Multi-Purpose, Standard, Hi-Arch and Utility description permit servicing procedures of these assemblies to be combined and discussed as one.

Single wheel front axle assemblies and twin wheel front axle assemblies each deserve separate discussions of servicing procedures. The procedures concerning axles of this type will include servicing the front pedestal and support assemblies.

Consult the Parts Book for information regarding the inter-change features of parts.

REMOVING FRONT AXLE AS A UNIT

Front axle assemblies of this description are removed as a unit when complete disassembly is not necessary.

Support the tractor with front wheel slightly touching the ground, refer to Fig. 1, and remove:

1. Lower grill panel.
2. Lower steering arm, No. 3, from pedestal shaft.
3. Thrust plate, No. 20, and shims from end of front pivot pin.
4. Front pivot support.
5. Front axle assembly by rolling the unit forward and out from tractor (a floor jack supporting the front axle center member facilitates easy handling when following this procedure). See Fig. 5.

Install the assembly as a unit by reversing the procedures for removing.

REMOVING FRONT AXLE TO DISASSEMBLE

When front axles of this description are to be completely disassembled, remove the assemblies as follows:

1. Slightly loosen the wheel lug nuts.
2. Support tractor with front wheels clearing the ground.
3. Remove:
   a. Front wheels.
   b. Lower grill panel.
   c. Grease fittings.
   d. Tie rods ends, Nos. 1 and 9, from spindle steering arms, Nos. 10 and 27. Fig. 1.
   e. Tie rods end No. 6, from main steering arm, No. 3.
   f. Main steering arm from pedestal shaft.
   g. Both R.H. and L.H. axle extension assemblies, Nos. 15 and 25, Fig. 1, (if so equipped).
   h. Pivot thrust plate, No. 20, and shims, No. 21.

NOTE: Save the shims.

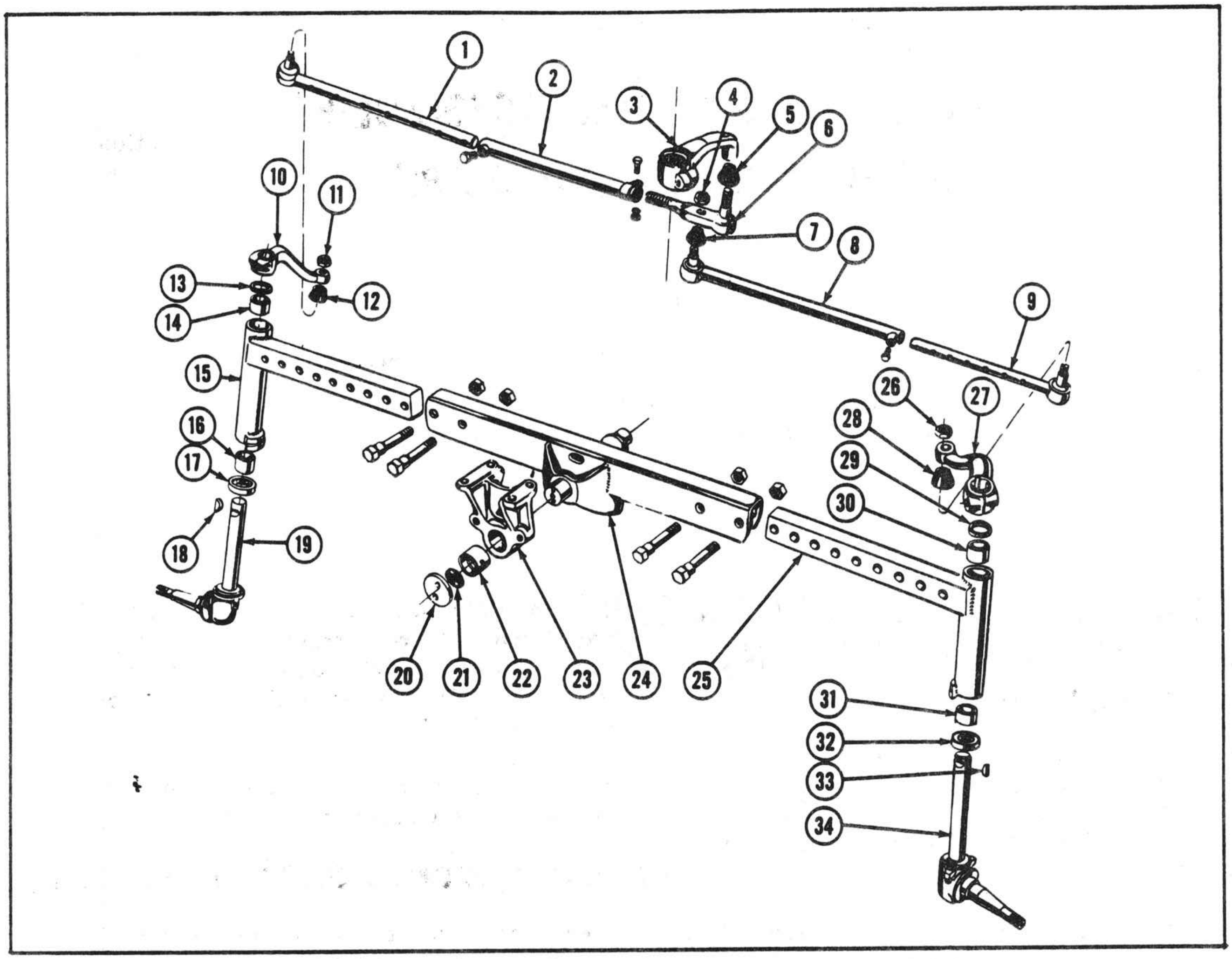

Fig. 1 – MF 50 Utility and MF 65 Standard Front Axle Assembly Nomenclature

1. Rod Assembly
2. Tube Assembly
3. Steering Arm
4. Nut
5. Dust Seal
6. Tie Rod End
7. Dust Seal
8. Tube Assembly
9. Rod Assembly
10. Spindle Steering Arm
11. Nut
12. Dust Seal
13. Dust Seal (Felt)
14. Spindle Bushing
15. Extension Assembly
16. Spindle Bushing
17. Thrust Bearing
18. Woodruff Key
19. Spindle Assembly
20. Thrust Plate
21. Shim Pack
22. Bushing
23. Pivot Support Assembly
24. Front Axle Assembly
25. Extension Assembly
26. Nut
27. Spindle Steering Arm
28. Dust Seal
29. Dust Seal (Felt)
30. Spindle Bushing
31. Spindle Bushing
32. Thrust Bearing
33. Woodruff Key
34. Spindle Assembly

i. Front pivot bracket, No. 23, from front axle support.

j. Axle center member, No. 24, by moving member forward and out of rear pivot pin bore.

DISASSEMBLING THE AXLE

Before disassembling, notice that the steering arms, the spindles, the axle extensions, and the tie rods are designed for the R.H. or L.H. sides.

NOTE: The mention of axle extensions does not apply to utility axles.

Remove: (Refer to Fig. 1)

1. Spindle steering arm, Nos. 10 and 27 from spindle, Nos. 19 and 34, by loosening clamp and removing Woodruff keys, Nos. 18 and 33.
2. Dust seals, Nos. 13 and 29, from spindle.
3. Spindle shaft from axle extension spindle shaft tubes, Nos. 15 and 25.
4. Spindle thrust bearings, Nos. 17 and 32, from spindle shafts.
5. Spindle bushings, Nos. 14,16,30 and 31.
6. Pivot bushing, No. 22, from front pivot bracket.

INSPECTING

Clean all parts thoroughly and inspect the component parts for damage and wear. The dimensions for new parts are listed as follows:

1. Rear pivot bushing --- 1.877 - 1.879 inch - inside diameter - pre-sized.

2. Front pivot bushings -- 2.002 - 2.004 inch - inside diameter - pre-sized.

3. Rear pivot pin --- 1.874 - 1.876 inch - outside diameter - pre-sized.

4. Front pivot pin --- 1.999 - 2.001 inch - outside diameter.

5. Spindle bushings -- sized after installation - 0.0035-0.005 inch clearance recommended between spindle and inside diameter of bushing.

NOTE: Inspect the rear pivot bushing bore located in the front axle support. If a correction has not been made to prevent the pivot bushing from working out of place, use a long 7/32" drill,

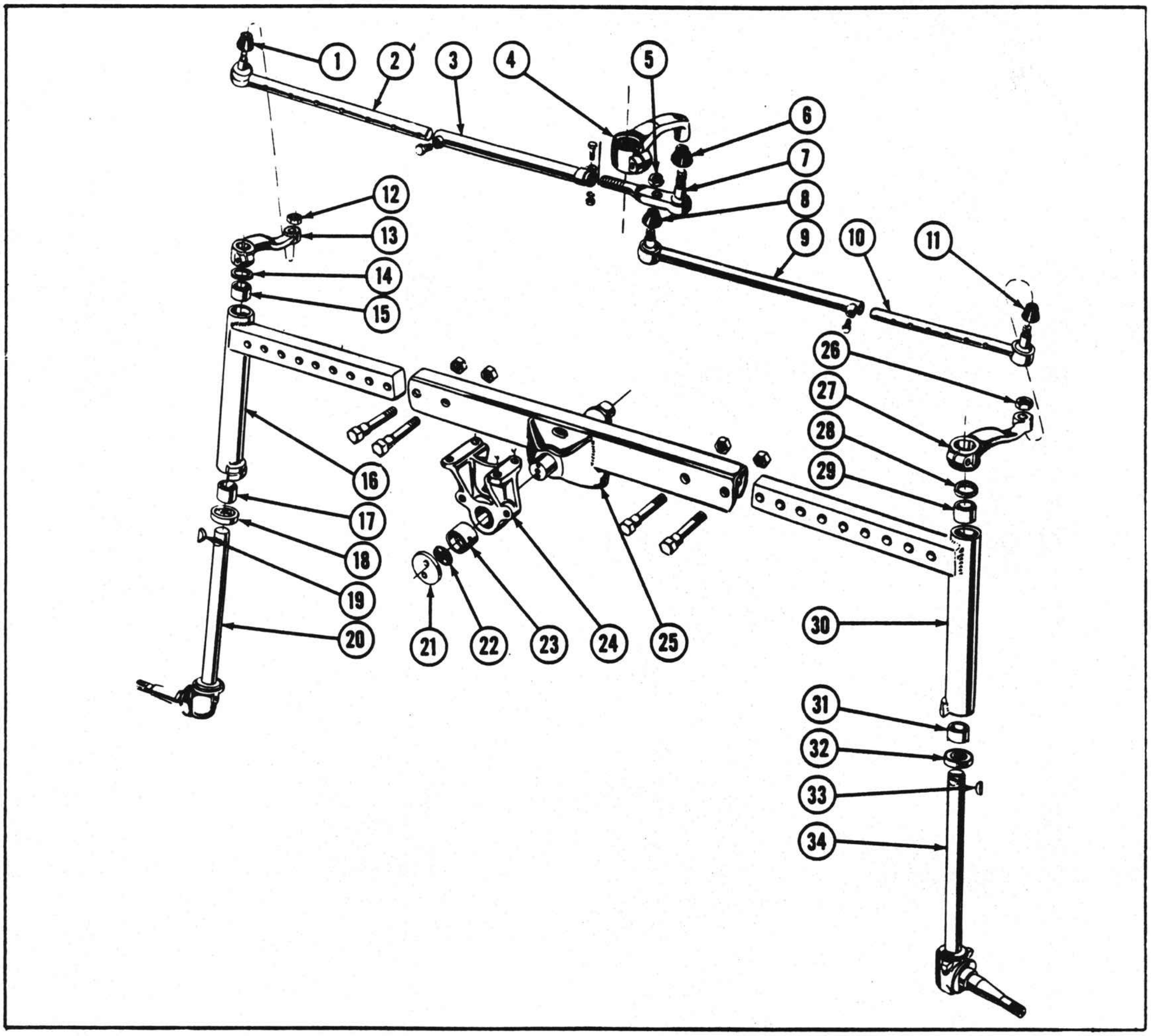

Fig. 2 – MF 50 and MF 65 Hi-Arch Front Axle Assembly Nomenclature.

1. Dust Seal
2. Rod Assembly
3. Tube Assembly
4. Steering Arm
5. Nut
6. Dust Seal
7. Tie Rod End
8. Dust Seal
9. Tube Assembly
10. Rod Assembly
11. Dust Seal
12. Nut
13. Spindle Steering Arm
14. Felt Dust Seal
15. Spindle Bushing
16. Extension Assembly
17. Spindle Bushing
18. Thrust Bearing
19. Woodruff Key
20. Spindle Assembly
21. Thrust Plate
22. Shim Pack
23. Bushing
24. Pivot Support Assembly
25. Front Axle Assembly
26. Nut
27. Spindle Steering Arm
28. Felt Dust Seal
29. Spindle Bushing
30. Extension Assembly
31. Spindle Bushing
32. Thrust Bearing
33. Woodruff Key
34. Spindle Assembly

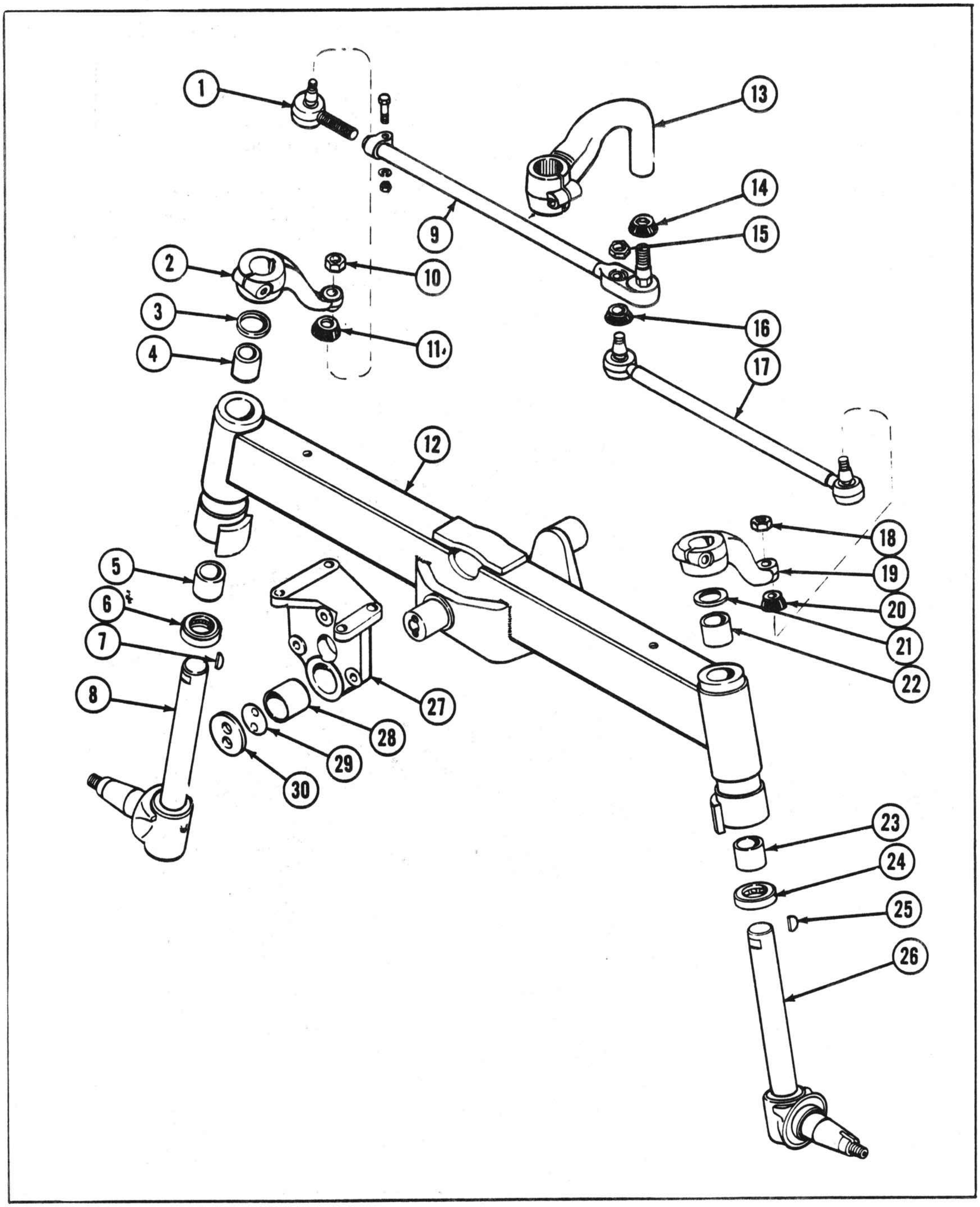

Fig. 3 – MF 65 Utility Front Axle Assembly Nomenclature.

1. Tie Rod End
2. Spindle Steering Arm
3. Felt Dust Seal
4. Spindle Bushing
5. Spindle Bushing
6. Thrust Bearing
7. Woodruff Key
8. Spindle Assembly
9. Tie Rod Assembly
10. Nut
11. Dust Seal
12. Front Axle Assembly
13. Main Steering Arm
14. Dust Seal
15. Nut
16. Dust Seal
17. Tie Rod Assembly
18. Nut
19. Spindle Steering Arm
20. Dust Seal
21. Felt Dust Seal
22. Spindle Bushing
23. Spindle Bushing
24. Thrust Bearing
25. Woodruff Key
26. Spindle Assembly
27. Pivot Support Assembly
28. Pivot Bushing
29. Shim Pack
30. Thrust Plate

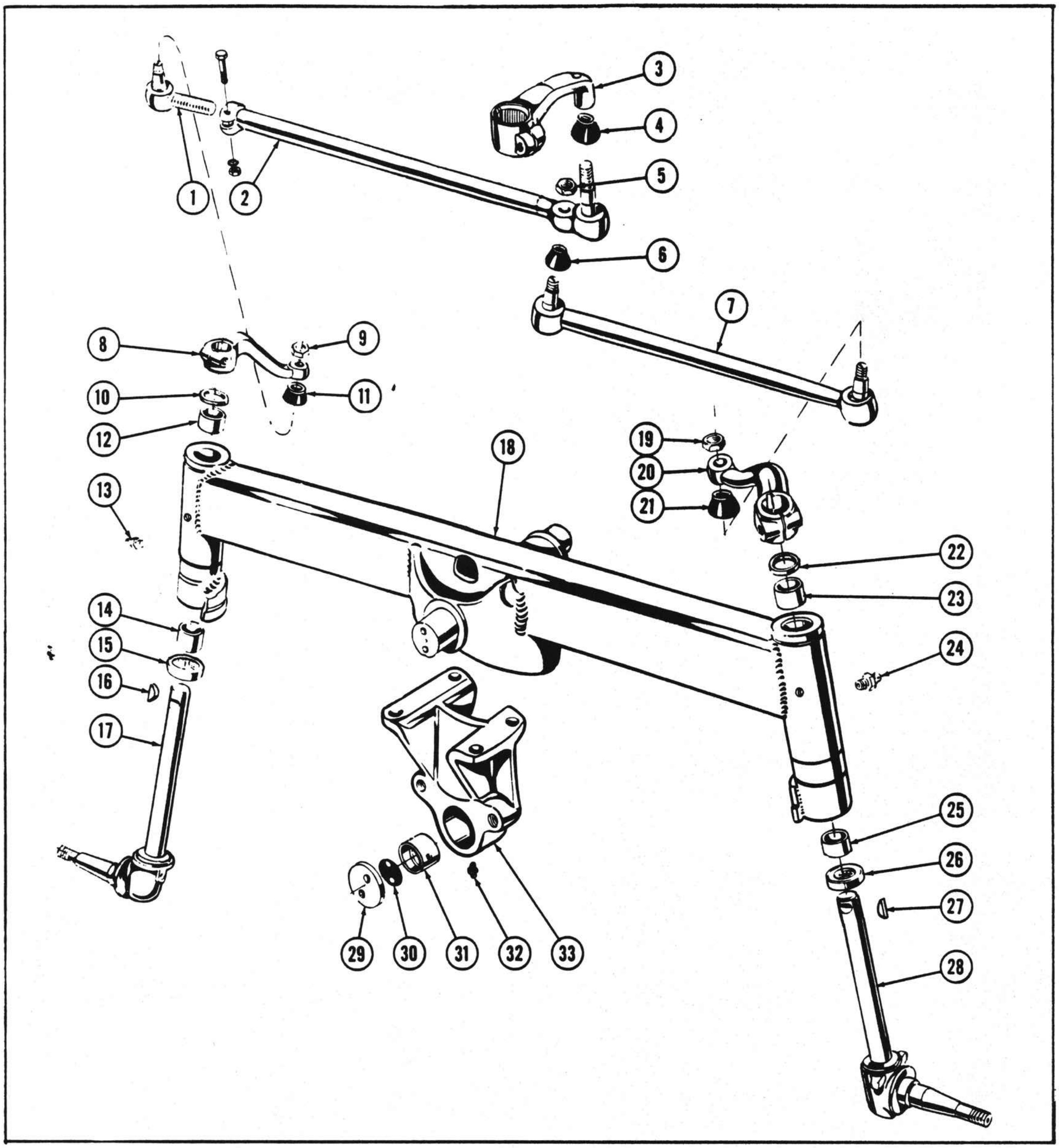

Fig. 4 — MF 50 Multi-Purpose Front Axle Assembly Nomenclature

1. Tie Rod End
2. Tie Rod Assembly
3. Main Steering Arm
4. Dust Seal
5. Nut
6. Dust Seal
7. Tie Rod Assembly
8. Spindle Steering Arm
9. Nut
10. Dust Seal
11. Dust Seal
12. Spindle Bushing
13. Grease Fitting
14. Spindle Bushing
15. Thrust Bearing
16. Woodruff Key
17. Spindle Assembly
18. Front Axle
19. Nut
20. Spindle Steering Arm
21. Dust Seal
22. Dust Seal
23. Spindle Bushing
24. Grease Fitting
25. Spindle Bushing
26. Thrust Bearing
27. Woodruff Key
28. Spindle Assembly
29. Thrust Plate
30. Shim Pack
31. Pivot Bushing
32. Grease Fitting
33. Axle Support Assembly

entering through grease fitting hole, to drill a spot in the bore 1/64" deep. When installing the bushing, line up the grease holes and insert a long punch to stake bushing into drill spot.

Replacement pivot bushings are pre-sized and do not require reaming when installed carefully with the proper tool.

Spindle bushings are renewable but require sizing after installation.

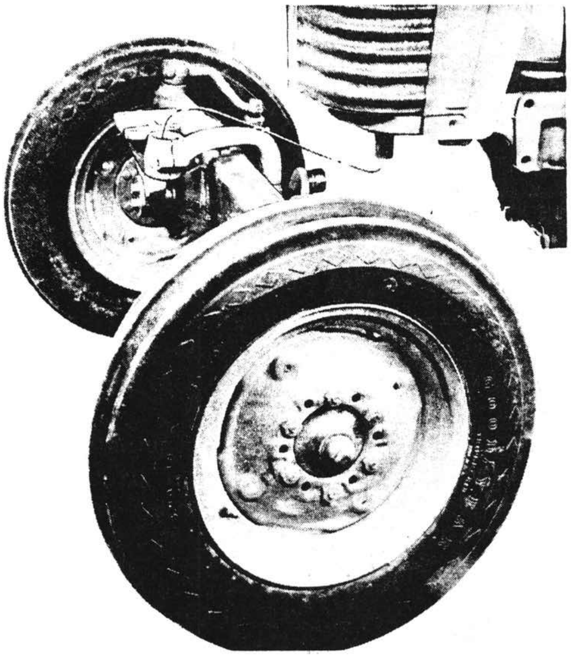

Fig. 5 — Removing Wide Front Axle Assembly

Tie rod ends are not adjustable for wear. Recommended toe-in adjustment is 0-1/4 inch.

End-play adjustment is 0.002-0.008 inch between support housing front face and front pivot bracket rear face.

ASSEMBLING THE AXLE

1. Install: (Refer to Fig. 1).

a. Bearing, No. 17, to spindle, No. 19.

b. Spindle bushings, Nos. 14 & 16, and ream to size.

c. Spindle through axle spindle tube, No. 15.

d. Dust seal, No. 13.

e. Woodruff key, No. 18, to spindle.

f. Spindle steering arm, No. 10, to spindle.

g. Tighten spindle, bolt arm clamp.

h. Repeat procedure for spindle assembly on other side.

INSTALLING THE AXLE

1. Install: (Refer to Fig. 1).

a. Rear pivot bushing, making certain grease holes are in alignment.

b. Axle main center-member, No. 24, by carefully inserting the rear pivot pin of center-member into support casting pivot pin bore.

c. Steering arm, No. 3, onto pedestal shaft and tighten clamp.

d. Front pivot bushing, No. 22, in front pivot bracket, No. 23.

e. Front pivot bracket to front pivot pin and attach to support casting.

f. Tie rods, No. 6, to main steering arm, No. 3.

g. Axle extensions, Nos. 15 and 25, to main center-member.

h. Tie rods Nos. 1 and 9, to spindle steering arms Nos. 10 and 27.

i. Shims, No. 21, (which are available in 0.002, 0.005 and 0.010 inch thickness) to the end of front pivot pin and secure with thrust plate, No. 20.

NOTE: End-play should be 0.002-0.008 inch between pivot bracket and center-member.

j. Wheels.

k. Lower grill panel.

l. Grease fittings.

2. Lubricate all grease fittings.
3. Adjust toe-in 0-1/4 inch.

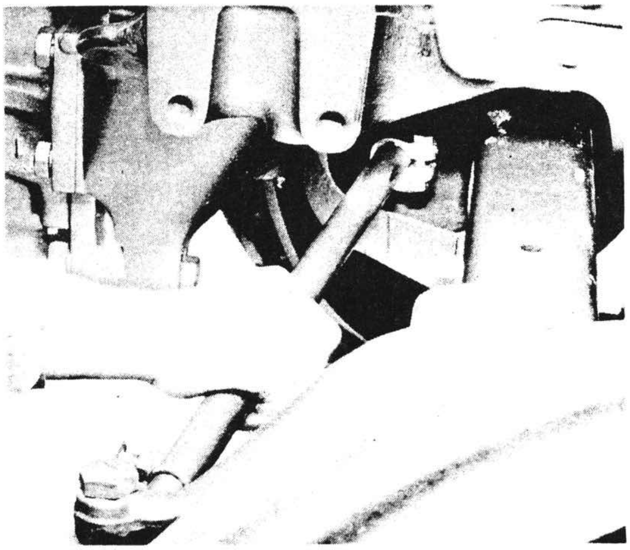

Fig. 6 — Adjusting Toe-In

ADJUSTING THE TOE-IN

To adjust the toe-in of all wide front axle models, loosen the right tie rod set screw at the outer end and the clamp bolt at the inner end. Turn the tube assembly, No. 2, Fig. 1, in (or out) to obtain the desired toe-in. See Fig. 6.

The toe-in is measured between the center tire ribs (at hub height) at both front and rear. Proper toe-in is obtained when the distance across the front is 0 to 1/4 inch less than the distance across the back. See Fig. 7.

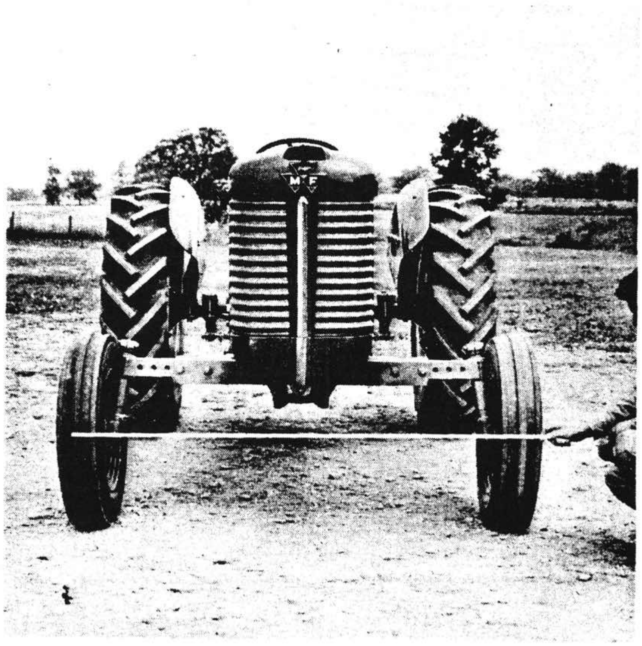

Fig. 7 – Measuring Toe-In

SERVICING THE ROW CROP SINGLE WHEEL FRONT AXLE

REMOVING

To remove the single wheel fork axle assembly, proceed according to the following instructions, and refer to Fig. 8.

1. Support the tractor so that front wheel barely touches the ground, and then remove:

   a. Lower grill panel.

   b. Sheet metal dust cap, No 1.

   c. Thrust plate, No. 2, by removing the cap screws.

   d. Shims, No. 3.

   e. Steering arm, No. 24, by working through opening in support casting, and loosening clamp bolt retaining the arm to wheel fork.

2. Carefully raise front end of tractor, while at the same time, withdrawing the wheel fork from below. See Fig. 9.

NOTE: Do not permit wheel fork shaft to become cocked out of line while removing.

3. Your purpose may or may not require removal of wheel; if it should be required, then do so as the first step of removal, refer to Group IV, Section B, Part 4 for instructions on removing wheel.

4. Remove the front axle support, No. 6, by removing the six cap screws.

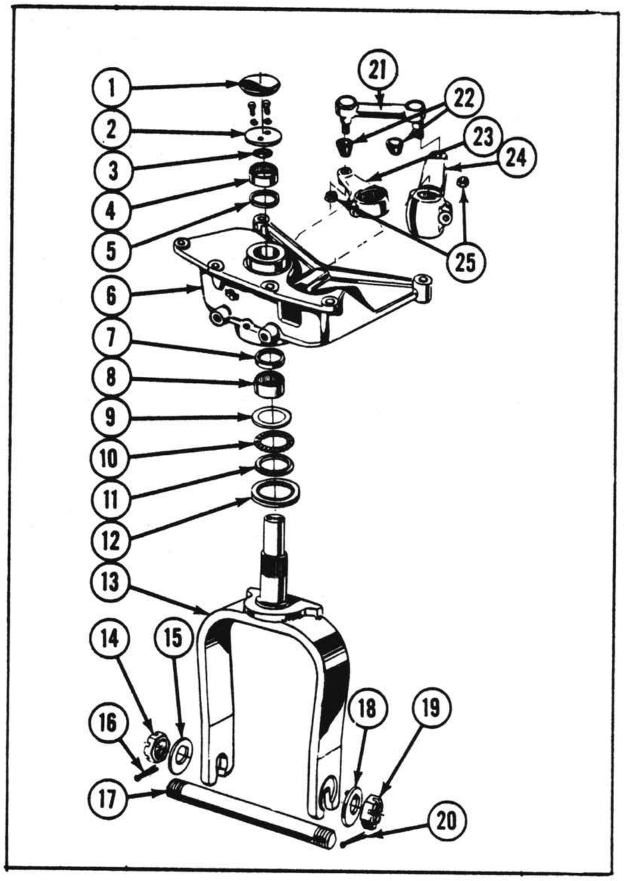

Fig. 8 – Single Front Wheel Axle Nomenclature

1. Dust Cap
2. Thrust Plate
3. Shim Pack
4. Needle Bearing
5. Oil Seal
6. Front Support Assembly
7. Oil Seal
8. Needle Bearing
9. Upper Bearing Race
10. Thrust Bearing
11. Lower Bearing Race
12. Oil Seal
13. Yoke Assembly
14. Castellated Nut
15. Eccentric Washer
16. Cotter Pin
17. Front Axle Shaft
18. Eccentric Washer
19. Castellated Nut
20. Cotter Pin
21. Arm Link Assembly
22. Dust Seals
23. Spindle Arm
24. Main Steering Arm

DISASSEMBLING

Remove: (Refer to Fig. 8).

1. The upper needle bearing, No. 4, from support casting No. 6.

2. Oil seal, No. 5, from support casting.

3. Oil seal, No. 7, from support casting.

4. Lower needle bearing, No. 8, from fork shaft, No. 13.

5. Bearing race, No. 9, from fork shaft.

6. Needle thrust bearing, No. 10, from fork shaft.

7. Bearing race, No. 11, from fork shaft.

8. Oil Seal, No. 12.

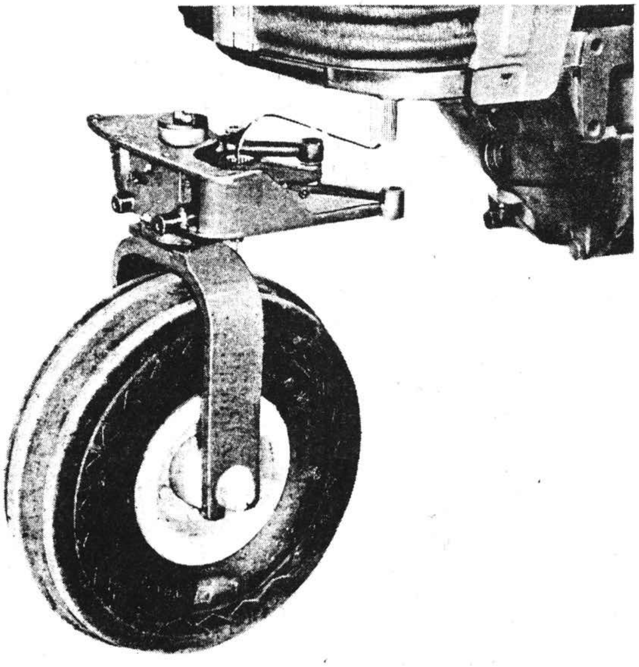

Fig. 9 – Removing Single Front Wheel Axle Assembly

INSPECTING

Clean all parts thoroughly; examine needle bearings and the needle thrust bearing. Replace new parts and oil seals if necessary.

ASSEMBLING AND INSTALLING

1. To assemble and install the wheel fork, simply reverse the steps of the disassembly procedure. A blind spline on the wheel fork and the steering arm will facilitate correct alignment of the two parts.

2. Adjust the up and down end-play of the wheel fork to 0.002-0.008 inch measuring clearance between lower face of support casting and upper face of wheel fork. Shims provide for this adjustment.

3. Adjust the front wheel (which has a taper roller bearing) to have a slight rotational drag.

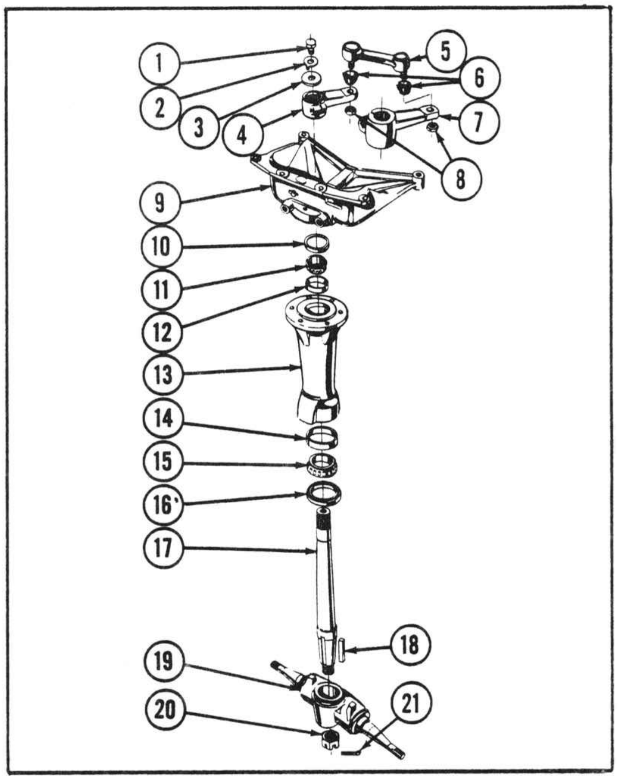

Fig. 10 – Twin Front Wheel Axle Nomenclature

1. Cap Screw
2. Lip Washer
3. Flat Washer
4. Spindle Arm
5. Arm Link Assembly
6. Dust Seals
7. Steering Arm
8. Nut
9. Front Support Assembly
10. Oil Seal
11. Upper Bearing Cone
12. Upper Bearing Cup
13. Pedestal Housing
14. Lower Bearing Cup
15. Lower Bearing Cone
16. Oil Seal
17. Spindle Shaft
18. Shaft Key
19. Front Spindle Assembly
20. Castellated Nut
21. Cotter Pin

4. Lubricate the assembly thoroughly.

NOTE: Always press or drive a needle bearing from the lettered side of bearing.

SERVICING ROW CROP TWIN WHEEL FRONT AXLES

REMOVING

To remove the twin wheel axle, proceed as follows:

1. Support the tractor with front wheels touching the ground (complete disassembly is more easily accomplished when wheels are removed).

2. Remove: (Refer to Fig. 10).

a. Lower grill panel.

b. Cap screw, No. 1, after unlocking lip washer, No. 2.

c. Flat washer, No. 3.

d. Steering arm, No. 7, working through support casting.

3. Carefully raise tractor, and at the same time, withdraw from below, the spindle shaft, No. 17, axle , No. 19, and wheels as an assembly. (See Fig. 11).

4. Remove:

a. Lower pedestal assembly, No. 13, from support casting, No. 9.

b. Front axle support, No. 9.

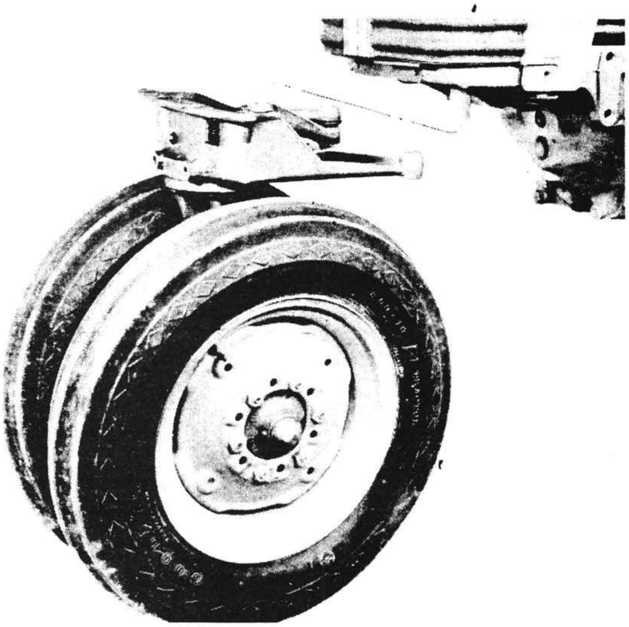

Fig. 11 – Removing Twin Front Wheel Axle Assembly

DISASSEMBLING

Remove: (Refer to Fig. 10)

1. Oil seals, Nos. 10 and 16, from pedestal, No. 13.

2. Upper and lower bearing cones, Nos.11 and 15, from pedestal.

3. Upper and lower bearing cups, Nos. 12 and 14, from pedestal.

4. Cotter pin and castellated nut, No. 20, from spindle shaft, No. 17.

5. Axle, No. 19 and key, No. 18, from spindle shaft.

INSPECTION

Clean all parts thoroughly and examine for wear. Replace new parts and oil seals if necessary.

ASSEMBLING AND INSTALLING

1. Reverse the disassembly procedures and tighten cap screw No. 1, Fig. 10 until all end-play is removed from spindle, leaving a slight drag on the bearings.

2. Blind splines on the lower spindle shaft in the steering arm provide for a correct installation.

See Group IV, Section B, Part 4 for wheel and hub information.

> *NOTE: When assembling, install new oil seals, and lightly grease the sealing surfaces. Rotate the shaft as it passes through seals.*

3. Lubricate the assembly thoroughly.

PART 5—POWER STEERING PUMPS—MF 35, 50 AND 65 TRACTORS

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DESCRIPTION

The power steering pump is constant running, gear type and is driven by the camshaft gear train. The pump delivers a volume of oil to the system with a regulated pressure of 1100 to 1200 psi, except on the MF 65 Diesel with the direct injection engine, tractor Serial No. 685 996 and up, which has a regulated pressure of 1500 psi. A relief valve is located in the pump to maintain this pressure.

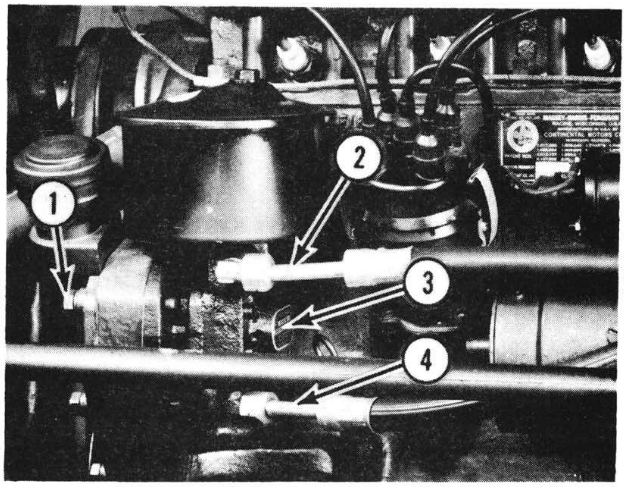

Fig. 1 – Barnes Power Steering Pump

1. Mounting Bolt 2. Return Line 3. Name Plate 4. Pressure Line

SERVICING PUMP (Gas Tractors)

The power steering pumps listed in this section are used on MF and TO 35, 40 and 50 Tractors, also MF 65 Tractors. The early model 35, 40, 50 and 65 Gas Tractors use the Barnes pump, which can be identified by a tag on the housing; see Fig. 1. This pump can be replaced for service by a Cessna pump which is also used on late model gas tractors. See Fig. 2 for identification of this pump.

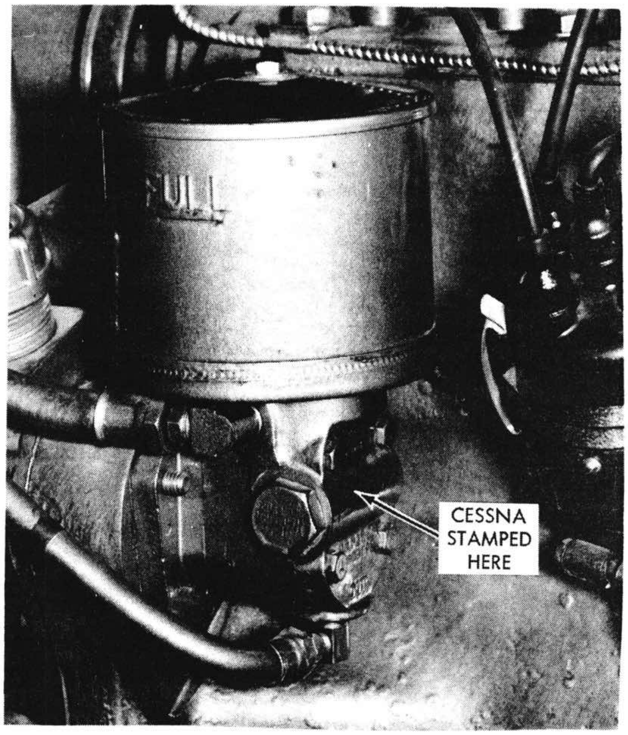

Fig. 2 – Cessna Power Steering Pump

NOTE: The pump drive gear used on the 35, 40 and 50 gasoline model tractors is different from that used on the 65 gasoline tractors.

REMOVING PUMP FROM TRACTOR

1. Disconnect pressure and return lines from pump.

2. Remove the three mounting bolts holding pump to engine block and remove pump assembly.

DISASSEMBLE BARNES PUMP

The Barnes Power steering pump can be identified by the Barnes tag located on the pump housing; see Fig. 1. This pump is driven by the timing gear train and delivers approximately 4 gallons per minute at an engine speed of 2000 rpm. It has a relief valve pressure of 1100 to 1200 psi.

The Barnes power steering pump can be repaired as far as replacing the internal parts such as shaft, gears, bearings, or seals. If the housing is damaged, the complete unit will have to be replaced. The pump bodies, Nos. 8 and 12, Fig. 3, are not available through parts. If the complete pump is to be replaced, it can be replaced by the Cessna pump shown in Fig. 2.

To disassemble the pump, proceed, as follows, and refer to Fig. 3 for description of parts.

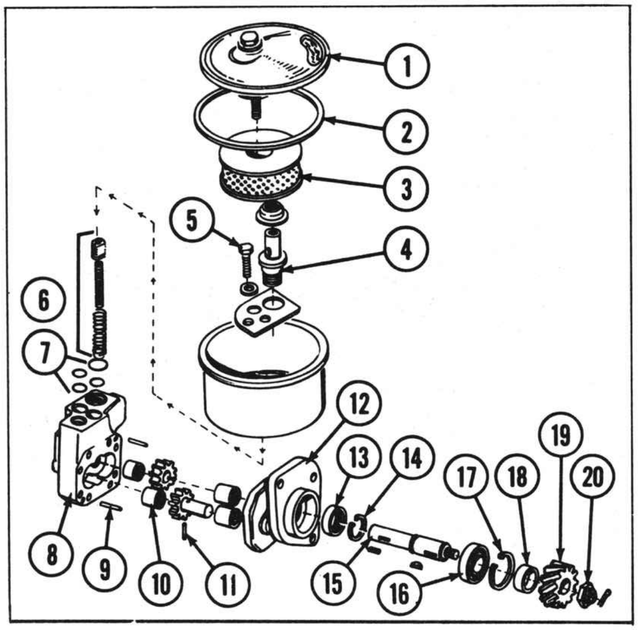

Fig. 3 – Barnes Power Steering Pump – Description and Sequence of Parts

1. Cover
2. Gasket
3. Filter
4. Retaining Stud
5. Capscrew
6. Relief Valve Assembly
7. "O"-Rings
8. Pump Body
9. Dowel Pin
10. Needle Bearing
11. Shear Pin
12. Front Plate
13. Oil Seal
14. Snap Ring
15. Shaft
16. Bearing
17. Snap Ring
18. Spacer
19. Gear
20. Nut

1. Remove reservoir retaining stud, No. 4, Fig. 3, and capscrew, No. 5, and remove reservoir.

2. Remove adjusting screw and pressure relief valve assembly, No. 6.

3. Remove the 8 screws securing the pump bodies together.

4. Remove nut securing drive gear, No. 19, and remove gear, key and spacer from shaft.

5. Remove snap ring, No. 17, from housing and remove shaft, No. 15, and bearing, No. 16, from housing.

6. Remove seal, No. 13.

REASSEMBLE BARNES PUMP

Inspect all parts for wear or damage. If housing, No. 8 or No. 12, Fig. 3, is damaged, replace the complete pump assembly. (These housings are not available in parts.) The Barnes pump can be replaced with the Cessna pump shown in Fig. 2.

1. Install new seal, No. 13, Fig. 3.

2. Install bearing, No. 16, on shaft, No. 15, against snap ring, No. 14.

3. Lubricate seal, No. 13, and insert shaft with bearing into housing and seal.

4. Secure shaft and bearing in housing with snap ring, No. 17.

5. Install pump drive gear, No. 19, with spacer, No. 18, and secure with nut, No. 20.

6. Place pump gears in place, as shown in Fig. 3; lubricate with light oil and place pump bodies together and secure with 8 screws.

> *NOTE: A gasket between the pump bodies is available, Part No. 1019 977 M1.*

7. Install relief valve assembly, No. 6. Turn adjusting screw in about 3 turns (this will have to be adjusted when the pump pressure is set). Refer to heading "Checking Pump Pressure".

8. Place new "O"-rings, No. 7, in place and install oil reservoir.

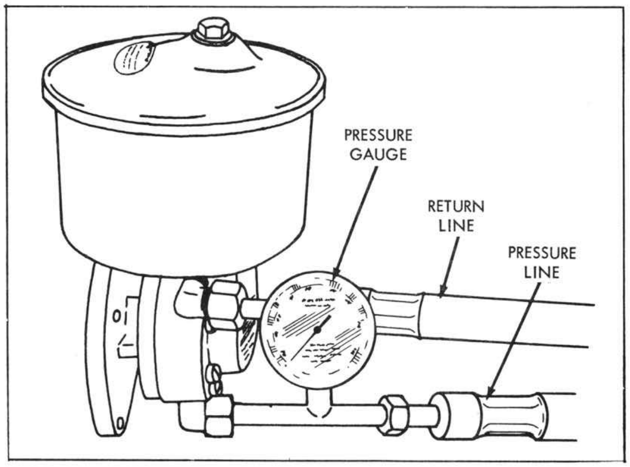

Fig. 4 – Diagram Illustration of Installed Pressure Gauge

9. Install pump on engine block and attach pressure and return lines.

10. Fill oil reservoir with type "A" transmission oil.

CHECKING PUMP PRESSURE

1. Install a pressure gauge in series with the pump pressure line, as shown in Fig. 4.

2. Run engine at low idle until oil in system is warm.

3. Advance engine speed to 2000 rpm and turn steering in either direction against stop to obtain a reading on the gauge.

Pressure reading should be 1100 to 1200 psi. To increase pressure, turn adjusting screw on relief valve in, to decrease, turn out.

> *NOTE: One turn of the adjusting screw will change the pressure approximately 300 psi.*

If the relief valve adjustment will not correct the pressure, the possible cause may be in the pump.

DISASSEMBLE CESSNA PUMP

The Cessna power steering pump can be identified by an M-F part number on the outside portion of the mounting base; also, it has a deeper reservoir than the Barnes pump with the name **FULL** on the side; see Fig. 2.

To disassemble, refer to Fig. 5, and proceed, as follows:

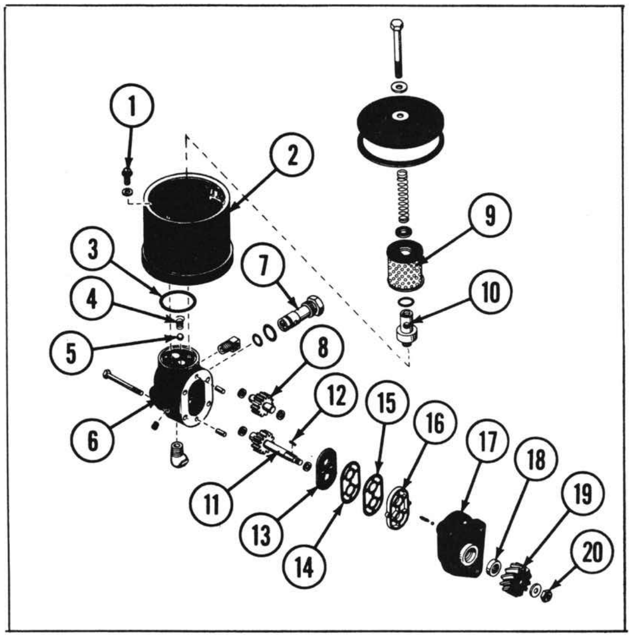

Fig. 5 – Cessna Power Steering Pump – Identification and Sequence of Parts

1. Capscrew
2. Reservoir
3. "O"-Ring
4. Spring
5. Ball
6. Pump Housing
7. Relief Valve
8. Idler Gear
9. Filter
10. Reservoir Seat Core
11. Gear and Shaft Assembly
12. Key
13. Diaphragm
14. Back-Up Gasket
15. Gasket Protector
16. Diaphragm Seal
17. Front Plate
18. Seal
19. Gear
20. Nut

1. Remove cover and filter element from reservoir.

2. Remove the reservoir seat core, No. 10, capscrew, No. 1, and remove reservoir. Note the check ball, No. 5, and spring which can be removed at this time.

3. Remove nut, No. 20, securing drive gear to the pump shaft and pull gear and key from shaft.

4. Remove the four bolts securing pump housings together.

5. Separate housings and remove gears and shafts.

6. Remove relief valve, No. 7, and remove relief valve assembly.

REASSEMBLE CESSNA PUMP

Inspect all parts for wear or damage. Replace worn or damaged parts. If gear or housing is worn or damaged, in most cases, the mating part will also be damaged and replacing the complete pump will be profitable. In cases where "O"-rings or seals have failed, the assembly of the pump is as follows; refer to Fig. 5 for description and sequence of parts.

1. Install seal, No. 18, with lip toward inside of pump.

2. Place diaphragm seal, No. 16, in groove in front plate, No. 17. (Work seal all the way into this groove.)

3. Place gasket protector, No. 15, firmly into diaphragm seal and next to this protector, the back-up gasket, No. 14.

4. Place metal diaphragm, No. 13, against back-up gasket with bronze side toward gears and oil grooves toward the two mounting holes in the front plate assembly.

5. Lubricate seal in front plate and place shaft and gear assembly, No. 11, in place.

6. Install key, No. 12, and gear, No. 19, on shaft and secure with nut.

7. Place idler gear and shaft, No. 8, into front plate assembly with unpainted end of shaft toward front plate.

8. Place pump housing over gears and secure with 4 bolts.

9. Inspect relief valve and install in pump housing.

10. Install check valve ball, No. 5, with spring, place "O"-ring, No. 3, in place and install reservoir.

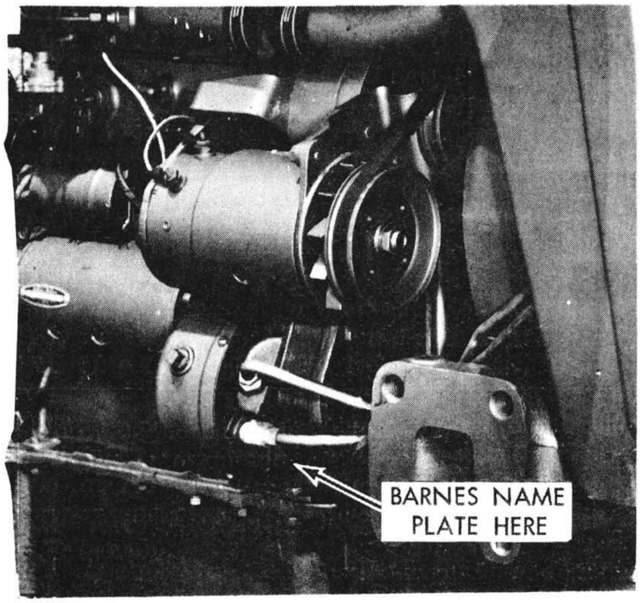

Fig. 6 – Barnes Pump Identification

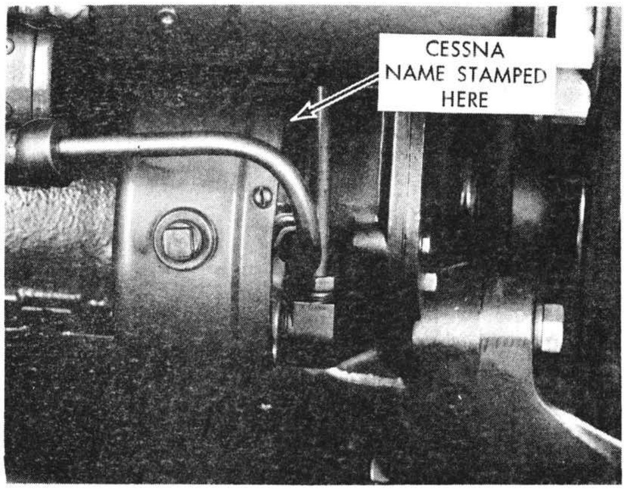

Fig. 7 – Cessna Pump Identification

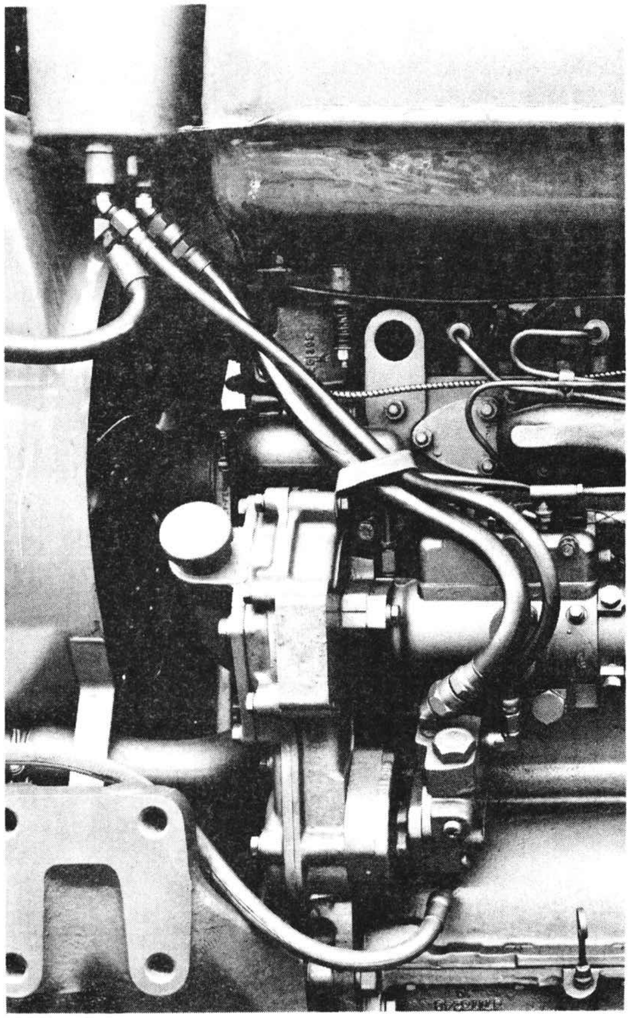

Fig. 8 – Barnes Pump Used on Early MF 65 Diesel Tractors

SERVICING PUMP (Diesel Tractors)

The power steering pumps listed in this section of the manual are used on MF 35, 50 and 65

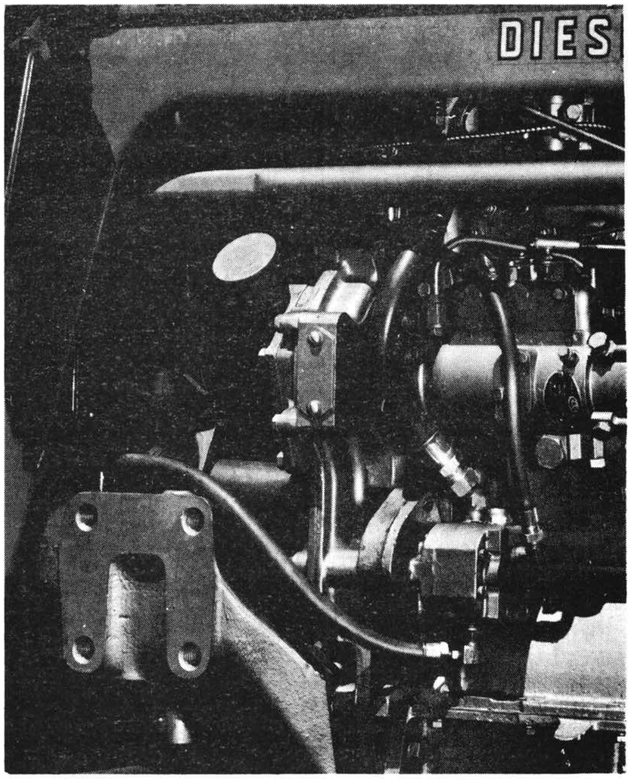

Fig. 9 – Hobourn-Eaton Pump Used on Early MF 65 Diesel Tractors

Diesel Tractors. Early models of MF 35 and 50 Diesel Tractors use a Barnes pump, which can be identified by the tag on the pump housing; see Fig. 6. For service, this pump can be replaced by the same Cessna pump used on the later models. This Cessna pump can be identified by the name "Cessna" stamped on the upper side of the front cover; see Fig. 7. These two pumps look similar, but can be identified by the manufacturer's name on the front cover, as shown in Figs. 6 and 7.

Early MF 65 Diesel Tractors prior to Serial No. 685 996 used a separate reservoir and pump. Two types of pumps were used. A Barnes pump, shown in Fig. 8, and a Hobourn-Eaton pump, shown in Fig. 9.

For servicing of Barnes pump, refer to paragraph "Disassemble Barnes Pump", gas tractors.

SERVICING SEPARATE RESERVOIR

For servicing the separate reservoir used on the early MF 65 Diesel Tractors prior to Serial No. 685 996, refer to Fig. 11 for description and sequence of parts. If it is necessary to repair the power steering pump, the reservoir should be checked and the filter element changed. After cleaning reservoir and replacing element, fill with type "A" automatic transmission oil to full mark on gauge assembly.

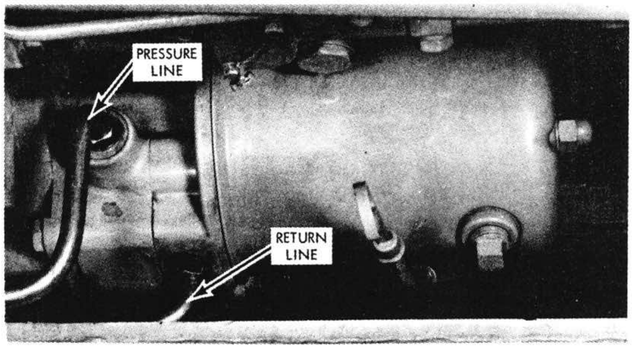

Fig. 10 – Wooster Pump Used on Late MF 65 Diesel Tractors

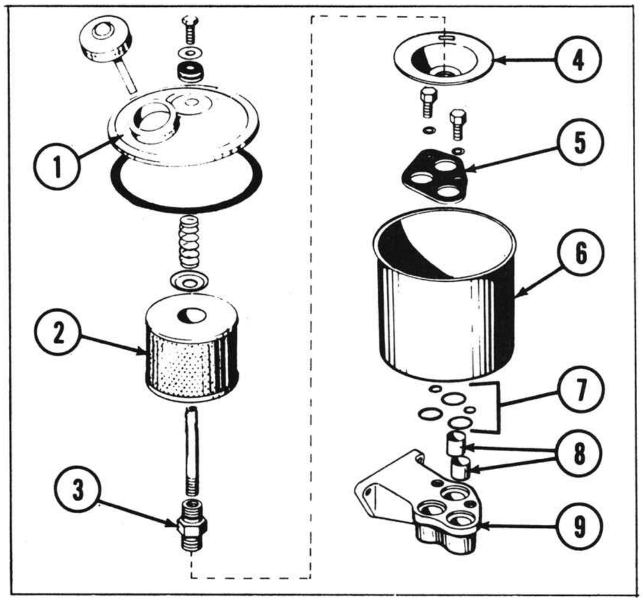

Fig. 11 – Reservoir Assembly – Identification and Sequence of Parts

1. Cover
2. Filter
3. Retaining Stud
4. Filter Element Support
5. Reinforcement Plate
6. Reservoir
7. "O"-Rings
8. "O"-Ring Retainers
9. Reservoir Base

The MF 65 Diesel Tractors after Serial No. 685 996 uses a Wooster power steering pump, shown in Fig. 10.

DISASSEMBLE WOOSTER PUMP

Refer to Fig. 12 and proceed, as follows:

1. Remove nut, No. 16, and special seal washer, No. 15.

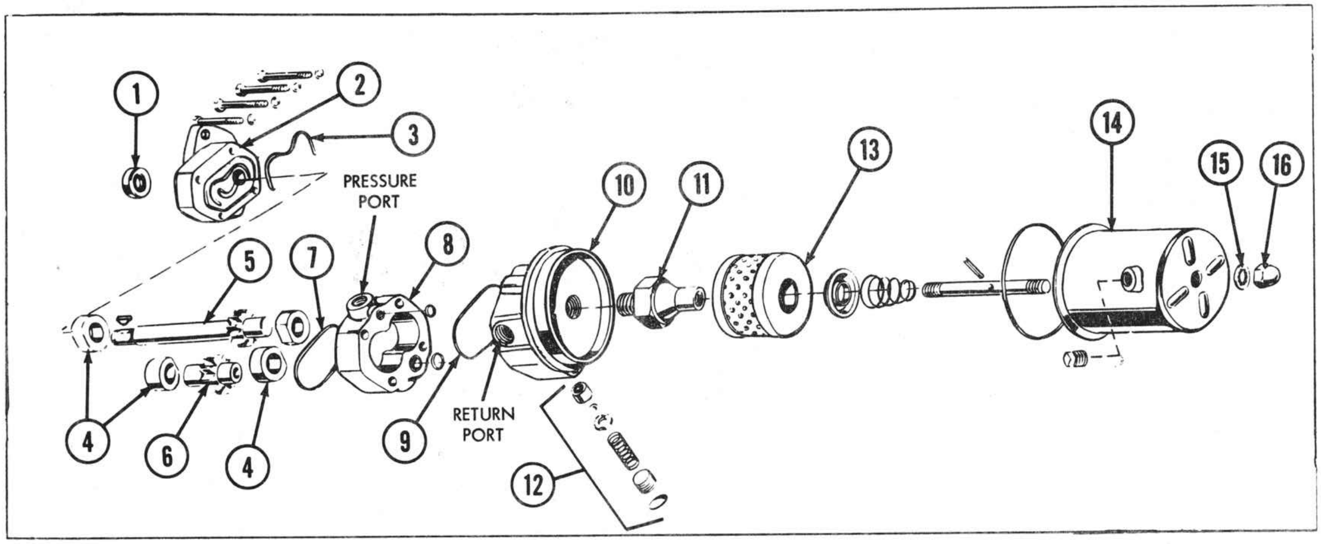

Fig. 12 – Wooster Power Steering Pump – Identification and Sequence of Parts

1. Oil Seal
2. Front Body
3. Seal
4. Bearing
5. Drive Gear and Shaft
6. Driven Gear and Shaft
7. Seal
8. Center Body
9. Seal
10. Rear Body
11. Reservoir Retainer
12. Relief Valve Assembly
13. Filter
14. Reservoir
15. Seal
16. Nut

2. Remove reservoir and filter assembly.

3. Remove the 4 capscrews securing the pump bodies together. The shafts, gear and bearings, Nos. 4, 5 and 6, will remain in the center body, No. 8.

4. Remove pump drive gear and key from shaft, No. 5.

5. Bump end of shaft, No. 5, on wood block to remove bearings, No. 4, and gears out of center body, No. 8.

REASSEMBLE WOOSTER PUMP

If the gears or bearings are damaged, check the center housing, No. 8, Fig. 12, which will probably be damaged. If this is the case, it will be necessary to replace the complete pump, because the center housing is not available in parts.

To assemble the Wooster pump, inspect all parts for wear or damage; refer to Fig. 12 and proceed, as follows:

1. If removed, apply a coat of sealing compound to the outer surface of seal, No. 1, and place in housing, No. 2

2. Install reservoir retainer, No. 11, on rear pump housing, No. 10, and clamp in vise with return port in housing, to left side.

3. Place seal ring, No. 9, and two "O"-rings in place on rear housing.

4. Install 2 bearings, No. 4, in center housing, No. 8, on oil passage side with grooves in bearings toward pump gears.

5. Place center housing, No. 8, with the oil passages down and the pressure port 90° counterclockwise from the return port, as shown in Fig. 12.

6. Place two retaining bolts in the center housing to hold in place while making this assembly.

7. Install long shaft, No. 5, in center housing on right side and short shaft, No. 6, on left side with the identification marks on the shaft down.

8. Place the 2 remaining bearings on the shafts and in the housing with grooves toward the pump gears.

9. Place seal, No. 3, in groove in front pump housing, No. 2.

10. Remove the 2 bolts previously installed to hold center housing in place, lubricate oil seal, No. 1, and carefully slide over shaft, No. 5.

11. Install 4 bolts to secure housings together and torque 28 to 32 ft.-lbs.

12. Install filter, spring, center stud and reservoir.

DISASSEMBLE AND REASSEMBLE CESSNA PUMP

To disassemble the Cessna Pump on Diesel model tractors, refer to paragraph "Disassemble Cessna Pump", in the gas tractor section, which is similar; also refer to this section for reassembly procedures.

GROUP IV — SECTION A — PART 6

MANUAL AND POWER STEERING GEAR HOUSING

MF 50 AND MF 65 TRACTORS

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Servicing the Steering Gear Housing 1

Servicing the Steering Gear Mechanism 5

Adjusting the Steering Mechanism 7

The power and manual steering gear housing are exactly the same. There are slight variations between the 50 (MF and MH) (Utility, Multi-Purpose, Hi-Arch Axle) models, the MF 65 (Standard and Hi-Arch Axle) models and the 50 (MF and MH) and MF 65 Row Crop models. As this difference is slight, servicing instructions will be given only once.

> *NOTE: Be sure to note the type of axle and model of tractor and the tractor serial number before ordering parts.*

SERVICING THE STEERING GEAR HOUSING

REMOVING AND DISASSEMBLING THE STEERING GEAR HOUSING

If repair of the steering mechanism only is involved, it is desirable to leave the steering gear housing attached to the top of the transmission. Remove the instrument panel and battery carrier as a unit as outlined in Group IV, Section C, Part 3. This completely exposes the steering gear housing (see Fig. 1).

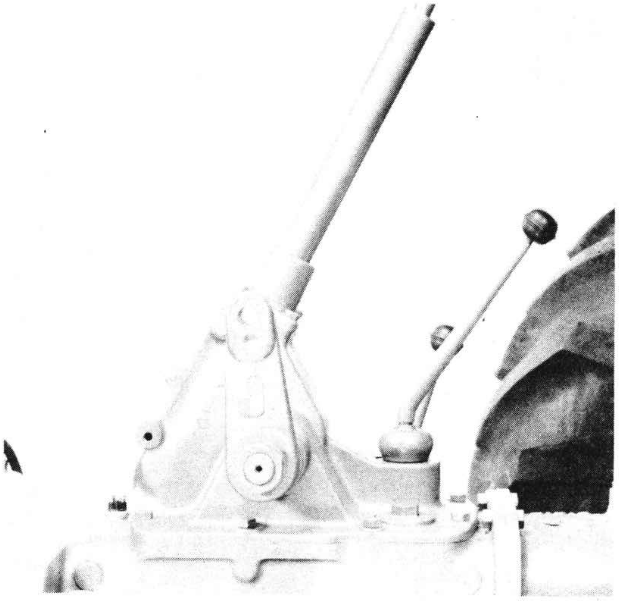

Fig. 1 – Steering Gear Housing

If it is deemed necessary to remove the steering gear housing from the transmission, however, simply remove the attaching cap screws and lift off the steering gear housing.

> *NOTE: Be sure to lift the steering gear housing straight up far enough to disengage the gear shift levers from the shift forks.*

To disassemble the steering gear housing, proceed as follows:

1. Remove the steering mechanism as outlined in "Removing and Disassembling the Steering Mechanism".

2. Separate the steering gear housing from the top of the transmission.

3. Collapse the spring (No. 23) and remove the retaining collar (No. 24, Fig. 2) and the spring from the gear selection shift lever.

4. Raise up the rubber boot (No. 27) and drift out the gear selection shift lever pin (No. 21, Fig. 2).

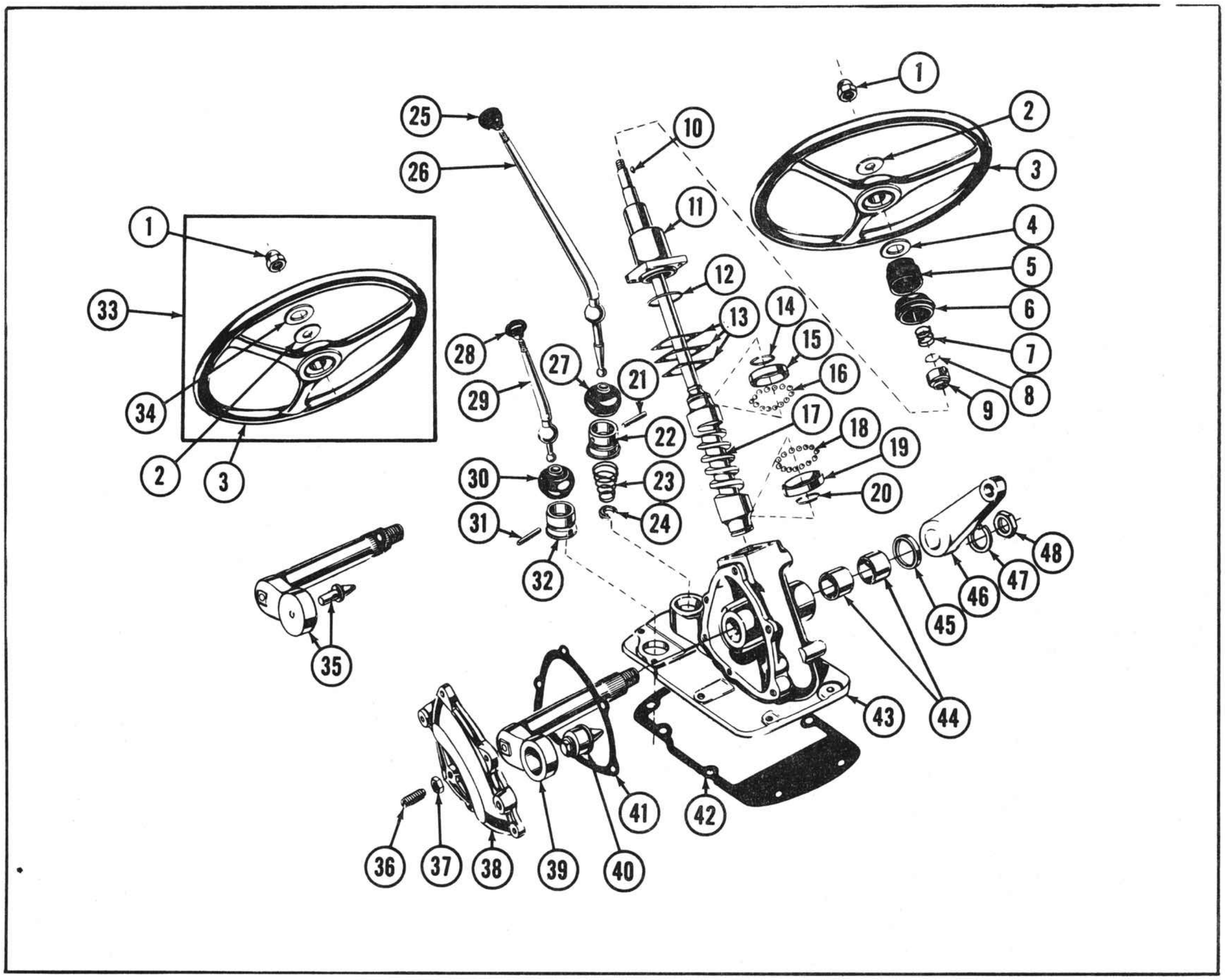

Fig. 2 — Steering Gear Housing Nomenclature

1. Dome Nut
2. Steel Washer
3. Steering Wheel
4. Felt Dust Seal
5. Chrome Cap
6. Rubber Dust Seal
7. Spring
8. Snap Ring
9. Shaft Top Support Bearing
10. Woodruff Key
11. Cover Tube
12. "O" Ring
13. Shim Pack
14. Snap Ring
15. Retainer Cup
16. Loose Ball Bearings
17. Steering Shaft
18. Loose Ball Bearings
19. Retainer Cup
20. Snap Ring
21. Shift Lever Pin
22. Shift Lever Cup
23. Spring
24. Spring Retainer Cup
25. Knob
26. Shift Lever
27. Rubber Boot
28. Knob
29. Planetary Shift Lever
30. Rubber Boot
31. Shift Lever Pin
32. Shift Lever Cup
33. Steering Wheel Assembly
34. Fiber Washer
35. Levershaft Assembly*
36. Adjusting Screw
37. Lock Nut
38. Side Cover
39. Levershaft
40. Pin Bearing Assembly
41. Gasket
42. Gasket
43. Housing
44. Bushings
45. Oil Seal
46. Pitman Arm
47. Lock Washer
48. Nut

*Used on row crop (narrow front axle) models only. See Text.

5. Raise the rubber boot (No. 30) and tap the planetary shift lever cup (No. 32) down until the shift lever pin (No. 31, Fig. 2) is below the bottom of the steering gear housing.

> *NOTE: Support the housing with a cylindrical sleeve so that the housing is not distorted.*

6. Drift out the planetary shift lever pin.

7. The shift lever cups may be tapped down through the housing or pulled from the bottom side.

> *NOTE: Support the housing with a cylindrical sleeve so that the housing is not distorted.*

SERVICING THE STEERING GEAR HOUSING

Oil Leaks at the Planetary Shift Lever

Under some conditions there may be some transmission oil seep out of the planetary shift lever cup on the MF 65 Tractor. This is due to a splash effect and not to the transmission breathing.

This leakage can easily be corrected in the following manner:

1. Remove the rubber boot from the shift lever.

2. Clean the shift lever ball and cup with a suitable cleaner.

3. With the shift lever in neutral, place an "O" ring (Part No. 851 145 M1) over the shift lever ball.

> *CAUTION: Do not force the "O" ring down against the ball.*

4. Cement the outside of the "O" ring to the housing with a suitable cement similar to 3M Sealer Compound, EC 750 (the Minnesota Mining Co.). Use the cement sparingly. The purpose of cementing is not to seal but to hold the "O" ring in position.

5. Allow a suitable time for the cement to dry before operating the tractor.

6. Install the rubber boot.

Gear Selection Shift Lever Cup

Under some circumstances, there may be some lifting of the gear selection shift lever cup experienced. When lifted far enough, the shift lever may lock in gear.

This problem may be easily corrected by:

1. Lift the rubber boot and remove the shift lever pin and engage the shift lever back into the fork.

> *NOTE: By pulling up against the spring mounted on the bottom of the shift lever, more freedom of movement may be obtained.*

2. Tap the shift lever cup back into position shown in Fig. 5.

3. Stake the cup and housing at several points around the circumference of the cup.

4. Install the gear selection shift lever and pin.

5. Replace the rubber boot to its original position.

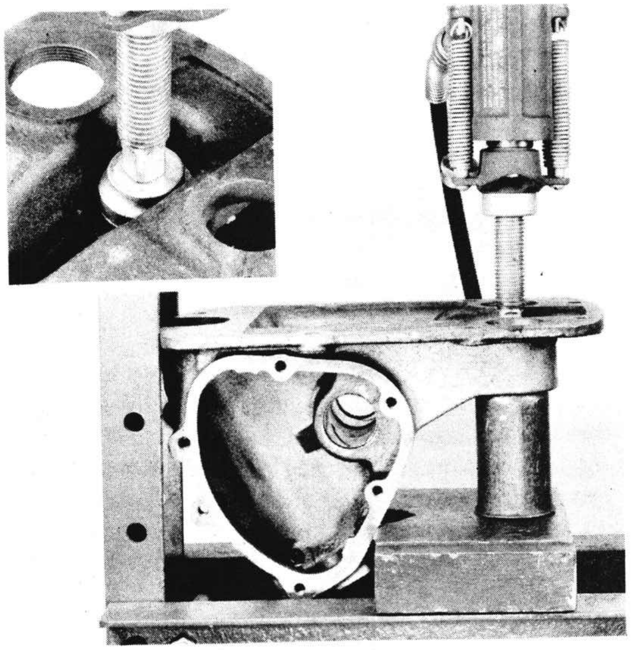

Fig. 3 — Installing Shift Lever Cups

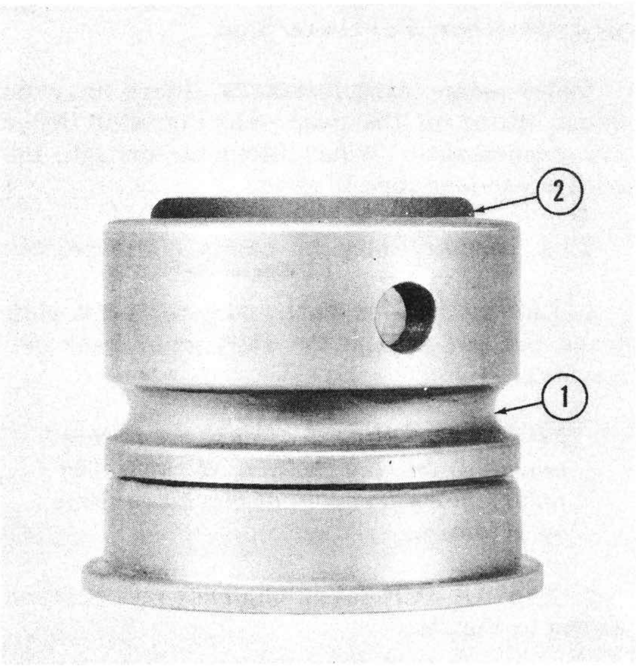

Fig. 4 – Shift Lever Cup – Old Type
1. Bottom Edge of Groove 2. "O" Ring

ASSEMBLING THE STEERING GEAR HOUSING

1. Mount the housing in a press as shown in Fig. 3 and press in the shift lever cups.

NOTE: Support the housing around the cup opening with a cylindrical sleeve to prevent distorting the housing. Press the cups in until the bottom edge of the groove (No. 1, Fig. 4) is even with the top of the housing as shown in Fig. 5. Make sure that the pin openings (No. 2, Fig. 6) are 90° to the direction of operation of the shift levers.

2. Install the following:

a. Shift levers and pins.

b. Spring assembly on bottom of gear selection shift lever.

c. "O" ring on top of planetary shift lever cup, as shown in Fig. 4. See "Servicing the Steering Gear Housing", Page 3. In newer model tractors, the shift lever cup has been modified, adding the shoulder (No. 1, Fig. 6) so that the "O" ring may be positioned in the cup and then the planetary shift lever installed.

d. Rubber boots over top of shift levers.

e. Threaded knobs to top of shift levers.

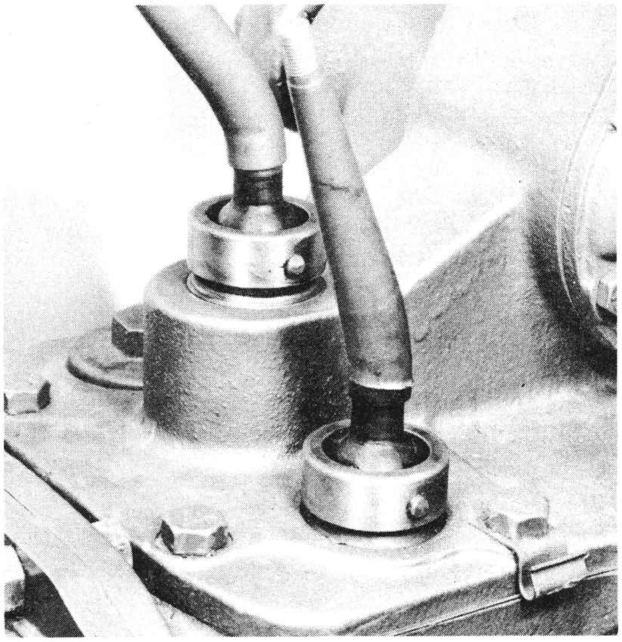

Fig. 5 – Shift Lever Cups Installed

3. Install the steering mechanism into the housing as outlined in "Assembling and Installing the Steering Mechanism".

INSTALLING THE STEERING GEAR HOUSING

1. Attach the steering gear housing to the top of the transmission. Use a new gasket.

NOTE: Make sure detent springs are in place. Lower the steering housing carefully into position, engaging the shift levers into the shift forks.

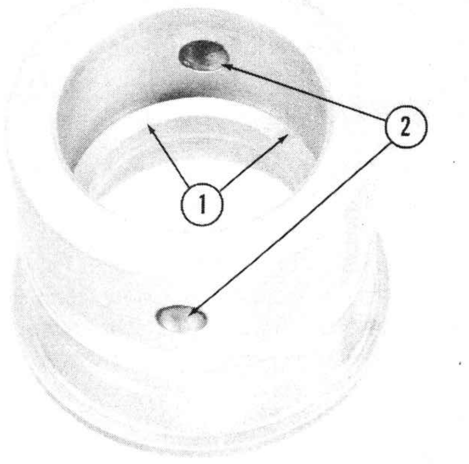

Fig. 6 – Shift Lever Cup – New Type
1. Shoulder 2. Pin Openings

2. Install the instrument panel and battery carrier as a unit.

3. Install the steering wheel.

SERVICING THE STEERING GEAR MECHANISM

REMOVING THE STEERING WHEEL

1. Remove the dome nut (No. 1), fiber washer (No. 34), and steel washer (No. 2, Fig. 2).

NOTE: Fibre washer is not used in MF 65 models.

2. Using a puller, remove the steering wheel from the steering shaft.

3. Complete removal by lifting the Woodruff key (No. 10), the dust washer (No. 4), the chrome cap (No. 5), the rubber dust seal (No. 6) and the bearing spring (No. 7, Fig. 2) off the steering shaft assembly.

REMOVING AND DISASSEMBLING THE STEERING MECHANISM

1. Remove the following:

a. The drag link from the pitman arm.

b. The pitman arm (No. 46) from the levershaft assembly (No. 39, Fig. 2).

c. The gear housing side cover (No. 38, Fig. 2).

d. The levershaft and stud assembly.

e. The cap screws attaching the column cover to the gear housing and remove the column housing (No. 11, Fig. 2).

NOTE: Notice the shim pack (No. 13) and carefully remove it and the sealing "O" ring (No. 12, Fig. 2) from the steering shaft cover.'

f. The steering shaft assembly (No. 17, Fig. 2) from the gear housing.

NOTE: Carefully work the steering shaft thrust bearings, out through the opening in the steering gear housing.

g. Tap out the cover tube bearing assembly (No. 9) from the steering shaft cover as shown in No. 1, Fig. 7.

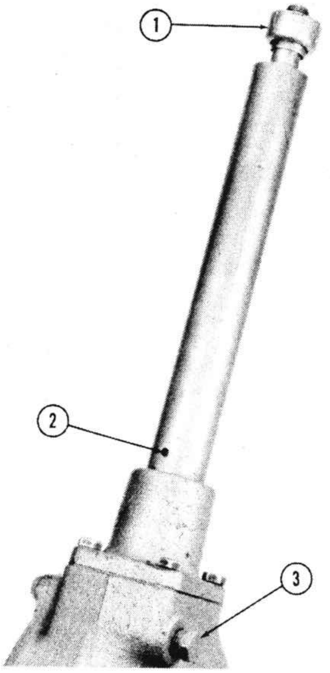

Fig. 7 – Steering Shaft Cover Tube
1. Shaft Top Support Bearing
2. Vent Hole
3. Lubricant Filler and Oil Level Plug

2. Lay the steering shaft in a shallow pan and release the snap rings (Nos. 14 and 20, Fig. 2).

NOTE: The 28 balls (14 in each race) will fall into the pan. See Fig. 8.

3. Remove the ball retaining cups (Nos. 15 and 19, Fig. 2) from the steering shaft.

4. Using a step plate and driver, drive out the oil seal (No. 45) and the two bushings (No. 44, Fig. 2).

INSPECTING AND SERVICING THE STEERING MECHANISM

1. Thoroughly clean all of the parts and examine them for excessive wear and damage.

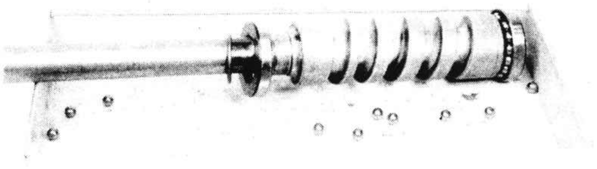

Fig. 8 – Removing the Shaft Thrust Bearings

2. After installation of the levershaft bushings, they must be reamed to give a clearance of 0.0005 to 0.003 inch between the levershaft and the bushings.

3. Always replace the sealing gaskets, oil seal and "O" ring.

4. Examine the stud bearing assembly on wide axle models. It must not show signs of damage or flat spots on the rollers. The proper bearing load is when it requires a slight drag (6-8 in.-lbs.) to turn the stud in its rollers.

> *NOTE: If bearing load must be adjusted, release the locking tabs and tighten (or loosen) the nut to adjust the load. Install a new locking tab washer before adjusting. Lock the nut into position when the adjustment is completed.*

> *CAUTION: Whenever converting a wide axle model tractor to a narrow axle model, be sure to replace the levershaft assembly (No. 39, Fig. 2) with the solid pin levershaft assembly (No. 35, Fig. 2).*

ASSEMBLING AND INSTALLING THE STEERING MECHANISM

1. Install the following:

a. Levershaft bushings. Ream the bushings to provide a 0.0005 to 0.003 inch clearance. Clean thoroughly after reaming the bushings.

b. Levershaft assembly oil seal. Lubricate the oil seal with brake fluid.

c. Ball retaining cups, balls (14) and snap rings.

d. The cover tube bearing assembly into the steering shaft cover tube.

2. Insert the steering shaft into the housing. Using the original shim pack, install the cover tube with the vent hole (No. 2, Fig. 7) to the front. Do not install an "O" ring on the cover tube at this time.

3. Install the Woodruff key, steering wheel, washer(s) and dome nut.

4. Attempt to pull up and push down on the steering wheel to check for steering shaft end-play.

> *NOTE: If end-play is present, remove sufficient thickness of shims to place a slight drag on the shaft as it is turned. Shims are available in thicknesses of 0.002, 0.003 and 0.010 inch.*

5. Remove the steering wheel and cover tube.

6. Position a lubricated "O" ring into the groove in the cover tube. Install the cover tube and the adjusted shim pack onto the housing, being careful not to damage the "O" ring. Install the cover tube so that the vent hole (No. 2, Fig. 7) is towards the front of the tractor.

7. Lubricate the levershaft and install it through the bushings and lubricated oil seal.

> *NOTE: Use care not to cut or damage the oil seal while installing the levershaft.*

8. Back the adjusting screw (No. 36, Fig. 2) out of the side cover a few turns and install the side cover. Use a new gasket.

9. Install the pitman arm on the levershaft.

> *NOTE: Master splines must be aligned for proper timing.*

10. Fill the gear housing to the correct level with recommended lubricant.

11. Adjust the steering mechanism as outlined in "Adjusting the Steering Mechanism".

INSTALLING THE STEERING WHEEL

Install the following onto the steering shaft:

1. Bearing spring.
2. Rubber dust seal.
3. Chrome cap.
4. Felt dust washer.
5. Woodruff key.
6. Steering wheel.

7. Steel washer.

8. Fiber washer (used only in MF 50 models).

9. Dome nut.

ADJUSTING THE STEERING MECHANISM

1. Adjust the steering shaft end-play as outlined in Steps 2 through 6 of "Assembling and Installing the Steering Mechanism". If the mechanism has not been disassembled, remove the drag link from the pitman arm and back the adjusting screw out of the side cover a few turns; check the steering shaft for end-play. Adjust the thickness of the shim pack according to the amount of end-play discovered.

> *NOTE: The use of a dial indicator would be helpful in determining approximately how much to alter the shim pack. The steering shaft operates under a slight preload.*

2. After the steering shaft preload has been adjusted, place the steering mechanism in its center or straight-ahead position. Turn in the adjusting screw until there is a slight drag (felt at the rim of the steering wheel) as the steering mechanism passes through its center or straight-ahead position. See Fig. 9. Tighten the lock nut.

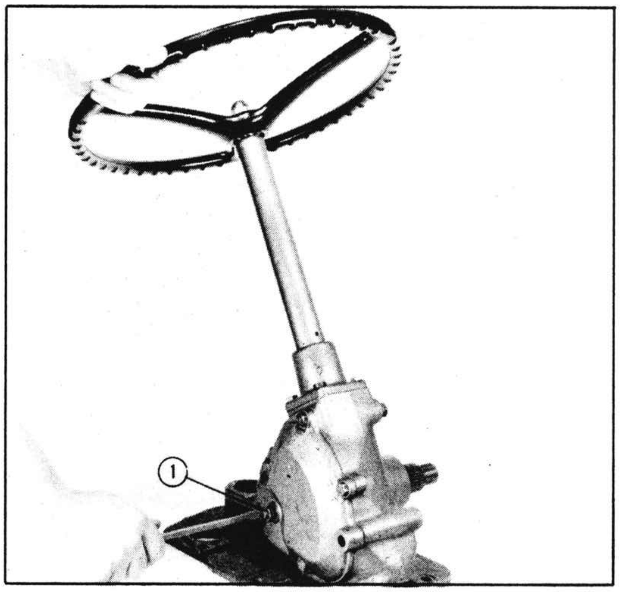

Fig. 9 — Adjusting the Steering Mechanism
1. Adjusting Screw

GROUP IV — SECTION A — PART 7

SERVICING THE MANUAL STEERING PEDESTAL AND DRAG LINK ASSEMBLY

MF 50 & 65 TRACTORS

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Page

Removing the Pedestal 1
Disassembling the Pedestal 2
Inspecting the Pedestal 2
Assembling the Pedestal 2
Installing the Pedestal 3

The manual steering pedestal and drag link assembly information found in this part of the Shop Manual, concerns the assembly required by axles of the wide type. Pedestal assemblies for Row Crop Single and Twin Front Axles are discussed in Group IV, Section A, Part 2.

Certain preparations must be made before this assembly can be completely removed and disassembled. Refer to Group IV, Section C, Part 6, and remove the grill, hood and side panels, and lower grill panel. Refer to Group IV, Section C, Part 6, and remove fan shroud and radiator assembly. Refer to Group IV, Section A, Part 2, and remove the front axle assembly from the front axle support (remove front axle as a unit, including wheels). Figs. 2, 3 and 4 show cut-away views of the pedestal, drag link and steering for the various front axle assemblies.

REMOVING THE PEDESTAL

Suport the tractor at the rear of the front axle support casting. Refer to Fig. 1, and proceed to remove:

1. Drag link, No. 15, from upper arm, No. 5.
2. Upper pedestal assembly, No. 9, pedestal shaft, No. 6, and upper arm as a unit by removing the cap screws securing the unit to front axle support, No. 12.

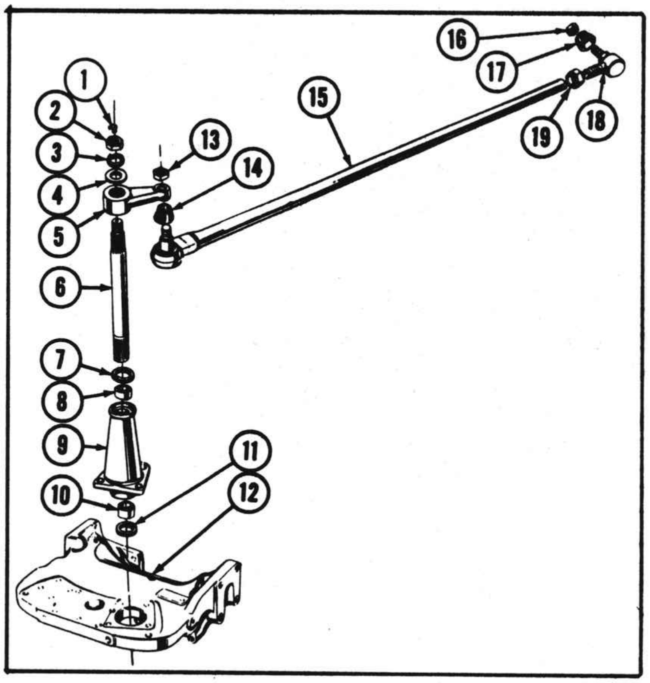

Fig. 1 – Pedestal and Drag Link Assembly Nomenclature

1. Grease Fitting
2. Nut
3. Lock Washer
4. Flat Washer
5. Upper Arm
6. Pedestal Shaft
7. Upper Dust Seal
8. Upper Bushing
9. Pedestal Housing
10. Lower Bushing
11. Lower Dust Seal
12. Axle Support Assembly
13. Nut
14. Dust Seal
15. Drag Link
16. Nut
17. Dust Seal
18. Tie Rod End
19. Lock Nut

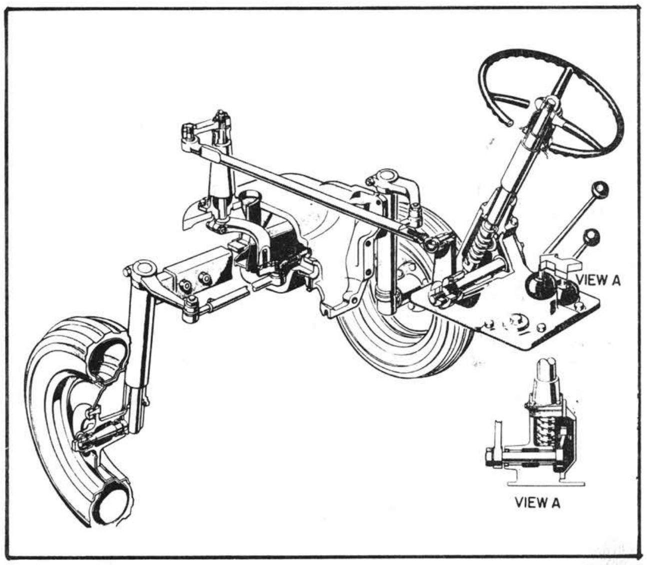

Fig. 2 – Four Wheel Front End and Steering Mechanism

3. Front axle support from tractor by removing the attaching bolts.

> *NOTE: The location and position of the R.H. and L.H. spacers should be installed in same order as removed.*

DISASSEMBLING THE PEDESTAL

Refer to Fig. 1, and remove:

1. Upper arm, No. 5, from the pedestal shaft, No. 6, by removing the grease fitting, nut, lock washer, and flat washer.
2. Pedestal shaft by pulling it through pedestal assembly, No. 9, from lower end.
3. Upper and lower dust seals, Nos. 7 and 11, from their seats in the upper pedestal assembly.
4. Upper and lower bushings Nos. 8 and 10, from pedestal assembly (remove only when necessary).

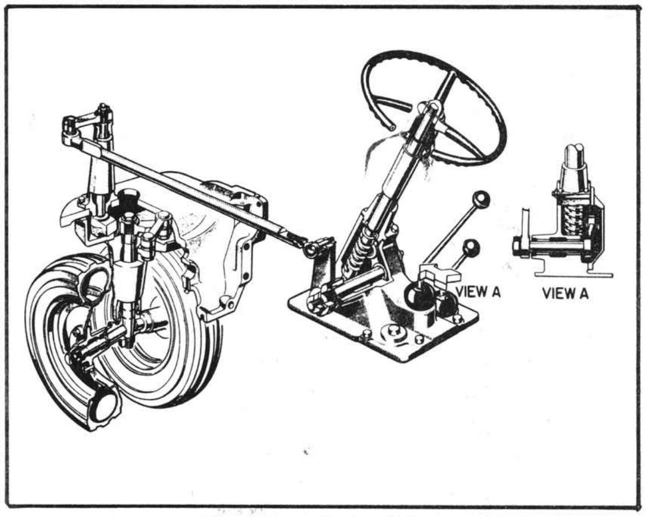

Fig. 3 – Twin Wheel Front End and Steering Mechanism

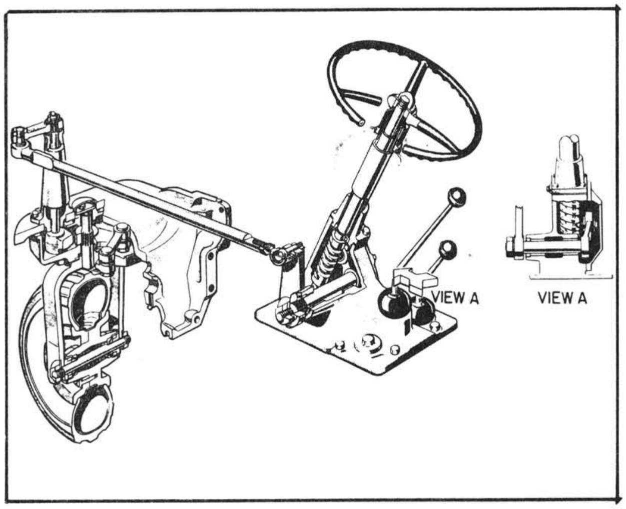

Fig. 4 – Single Wheel Front End and Steering Mechanism

5. Grease fitting from the front axle support, No. 5, Fig. 5.
6. Rear pivot pin bushing No. 4, Fig. 5, from the pivot pin hole located in the support casting.
7. R.H. and L.H. spacers.

INSPECTING THE PEDESTAL

Clean all parts thoroughly and inspect for wear and damage.

Pedestal shaft should have a 0.0005-0.002 inch clearance in the bushings.

New pedestal shaft bushings should be reamed to 1.5005-1.5015 inch after being installed in the upper pedestal assembly.

> *NOTE: Inspect the rear pivot bushing bore located in the front axle support. If a correction has not been made to prevent pivot bushing from working out of place, use a long 7/32" drill, entering through the grease fitting (No. 5, Fig. 5) hole, to drill a 1/64" deep spot in the bore. When installing the bushing, line up the grease holes, and with a long punch inserted through grease hole, stake the bushing into the drill spot.*

ASSEMBLING THE PEDESTAL

Refer to Fig. 1, and install:

1. Upper and lower pedestal bushings, Nos. 8 and 10, into the pedestal assembly, No. 9. Press them into place evenly and ream to size.
2. Upper and lower dust seals, Nos. 7 & 11, into their respective seats in the pedestal assembly. Use new dust seals whenever possible.
3. Pedestal shaft, No. 6, into the pedestal assembly. Lightly grease the shaft and start it through lower base of pedestal assembly.

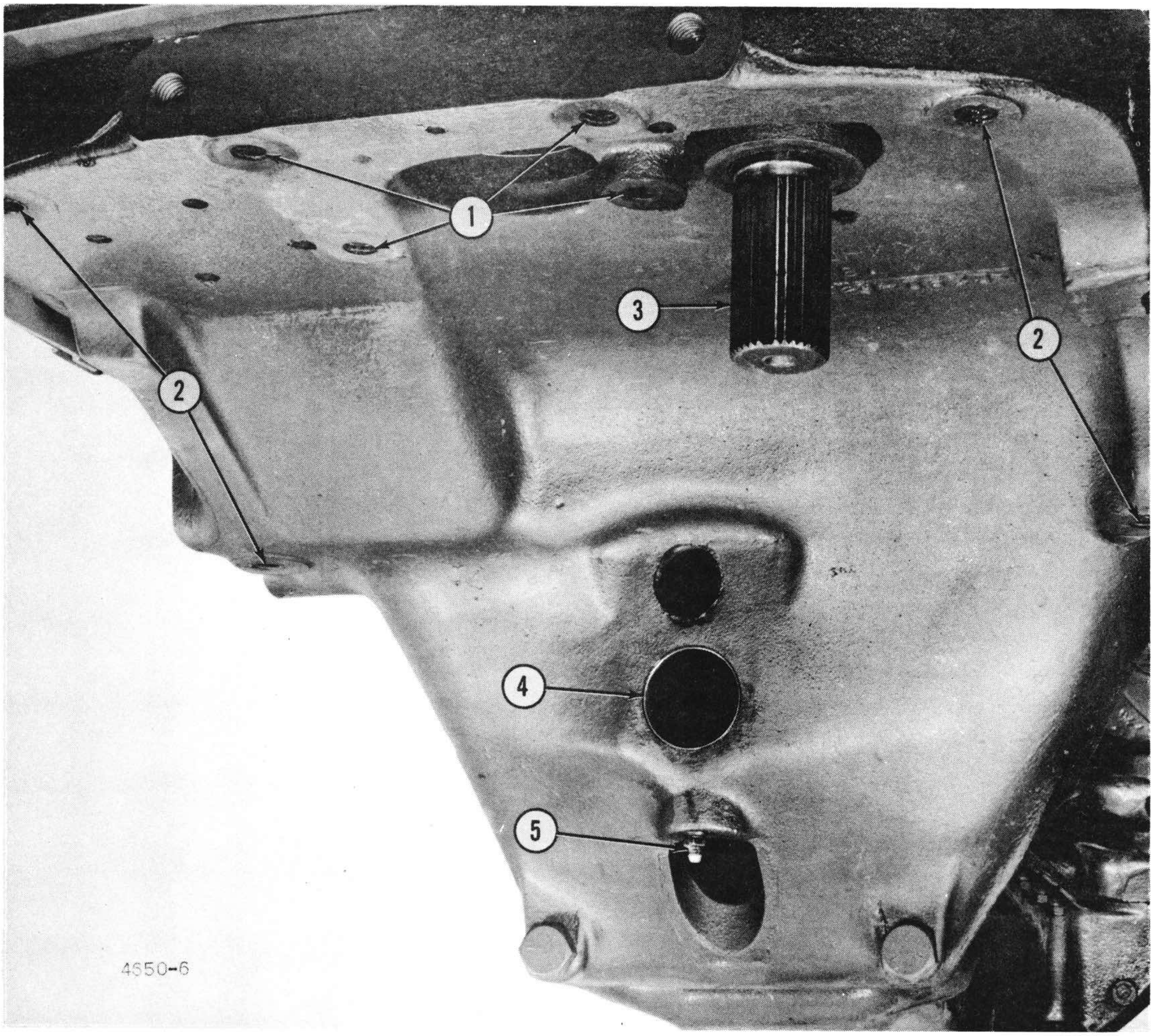

Fig. 5 — Front Axle Support Assembly

1. Tapped Holes for 4-Wheel Models
2. Tapped Holes for Tricycle Models
3. Pedestal Shaft
4. Rear Pivot Pin Bushing
5. Grease Fitting

4. Upper arm, No. 5, to the upper end of pedestal shaft; a blind spline provides for proper alignment. Secure with flat washer, lock washer and nut.

5. Pivot bushing, No. 4, Fig. 5, into the bore in front axle support as described in note. (See "Inspecting").

INSTALLING THE PEDESTAL

Refer to Fig. 1, and install:

1. Front axle support assembly, No. 12, to tractor as follows:

a. Insert attaching bolts through the holes provided in the front axle support.

b. Place the R.H. and L.H. spacers in position on the bolts now protruding from rear side of support assembly.

c. Line up the holes in the support with holes in the tractor and tighten the bolts.

2. Upper pedestal assembly, No. 9, pedestal shaft, and upper arm as one unit. Position the unit to its proper location on front axle support and secure with cap screws.

3. Front axle assembly, referring to Group IV, Section A, Part 2 for instructions.

4. Drag link, No. 15, after aligning front wheels in a straight line position and centering steering wheel.

5. Lubricate all grease points thoroughly.

PART 8. SERVICING THE POWER STEERING PEDESTAL, CYLINDERS AND VALVES
MF 50 & 65 TRACTORS

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Both manual and power steering utilize many common parts such as the steering housing, gears, etc.; however, the power steering requires an altered pedestal assembly and upper arm and the addition of a pump, power cylinder, control valve, connecting linkage and hoses.

The power cylinder and control valve mounted next to the pedestal are the external type; that is, they are not integral with the steering housing. By opening the R.H. or L.H. grills, the adjustments on the power steering mechanism may be readily made. The control valve, atop the power cylinder, regulates the flow of oil to and from the cylinder while the power cylinder provides the force to rotate the front wheels. The piston end of the power cylinder is attached to a bracket on the top of the main front support casting and barrel end of the cylinder is secured to the splined arm on the pedestal shaft. The control valve is connected to the same arm that the drag link is fastened to. This arm is not splined to the pedestal shaft and is free to turn. The only connection between the valve arm and the cylinder arm is a valve adjusting pin. This pin secured to the valve arm extends into the cylinder arm in a loose fitting socket.

SERVICING THE POWER STEERING VALVES

The following procedure is for valves on MF 50 tractors prior to Serial Number 516 788 and on MF 65 tractors prior to Serial Number 650 369. This valve may be further identified as being the one which sets on top of the cylinder and is not a part of the cylinder end cap. Fig. 1 shows the oil flow for a right and left turn.

REMOVING THE VALVE

1. Drain the power steering system.

2. Open the R.H. grill door and disconnect the hoses to the valve.

3. Remove the bolts securing the valve to the cylinder.

4. Disconnect the linkage to the pedestal at pin (No. 1, Fig. 2) and lift away the valve.

DISASSEMBLING THE VALVE

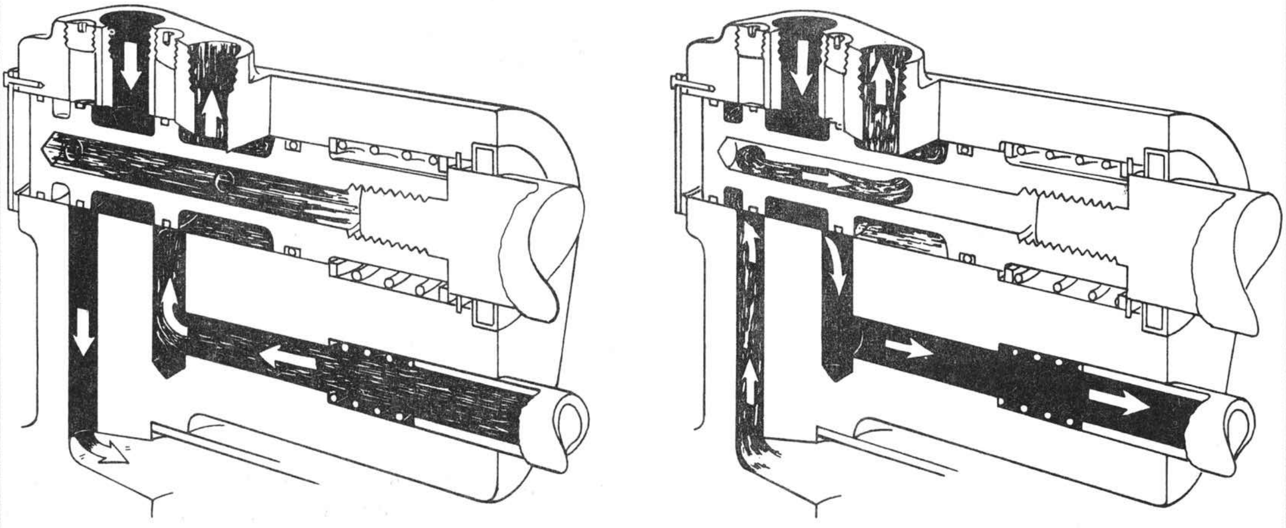
1. Drive out the roll pin attaching the adjusting linkage (No. 2) to the link (No. 3, Fig. 2).

NOTE: Make sure that the slotted end of the valve end rod assembly (No. 13, Fig. 3) is not collapsed while driving the roll pin in or out.

2. Pierce with a sharp center punch and pry out the dust seal retainer (No. 17) and take out the dust seal (No. 16, Fig. 3).

3. Remove the snap ring (No. 15) and remove the spool from the valve body (No. 4, Fig. 3).

4. Slide the thrust washer (No. 14) from the valve link (No. 13, Fig. 3).



OIL FLOW FOR RIGHT TURN. OIL FLOW FOR LEFT TURN.

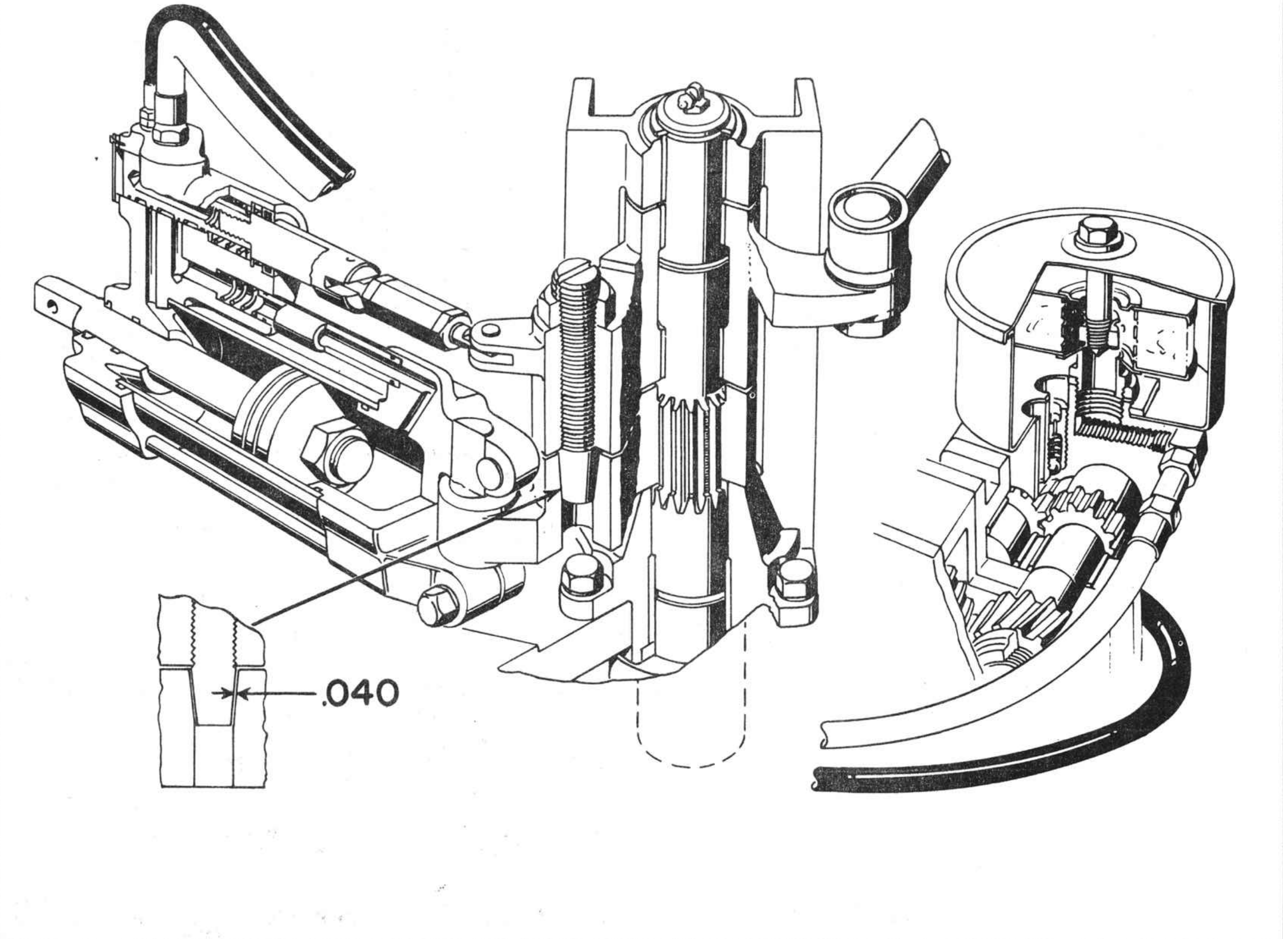


Fig. 1. - Power Steering Oil Flow

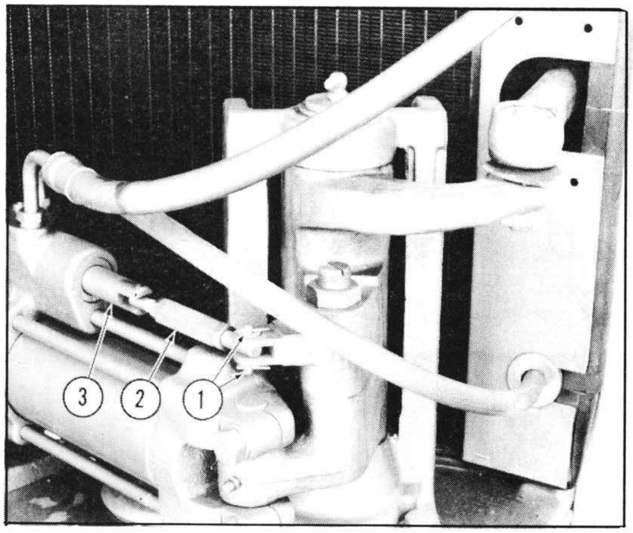


Fig. 2 - Power Steering Valve Linkage

1. Connecting Pin Assembly
2. Adjusting Link
3. Valve End Rod Assembly

5. Mount the valve spool (No. 5, Fig. 3) in a soft jawed vise and unscrew the valve link from the spool.

6. Slide the valve guide (No. 11), thrust washer (No. 9) and spring (No. 8, Fig. 3) from the spool end.

7. Tip the spool on end and allow the inner spool (No. 7) and spring (No. 6, Fig. 3) to fall out of the spool.

NOTE: If the spool requires replacement, the entire valve must be replaced as the inner spool, main spool and valve body are a "matched" set.

8. Remove the snap ring (No. 1) and withdraw the end plug (No. 2) and "O" ring (No. 3, Fig. 3) from the valve body.

REMOVING AND DISASSEMBLING THE VALVE

The following procedure is for valves on MF 50 tractors after Serial Number 516 788 and on MF 65 tractors after Serial Number 650 369. This valve may be further identified as being the one which is an integral part of the cylinder end cap.

1. Remove the following (refer to Fig. 4):

    a. Cylinder from the tractor as outlined in "Removing the Cylinder".

    b. Allen head screws (No. 5) from the valve body. Locate a hole in the spool by pulling the valve spool against the spring pressure and rotating it at the same time. Once located, install a small punch through the Allen head screw opening into the hole in the valve spool.

    c. Valve end (No. 14) by unscrewing it from the valve spool (No. 8). Remove the punch.

    d. Oil seal (No. 17) from valve body (No. 6).

    e. Screw nails (No. 1) securing end cap (No. 2) to valve body. Remove end cap (No. 2) and felt dust seal (No. 3).

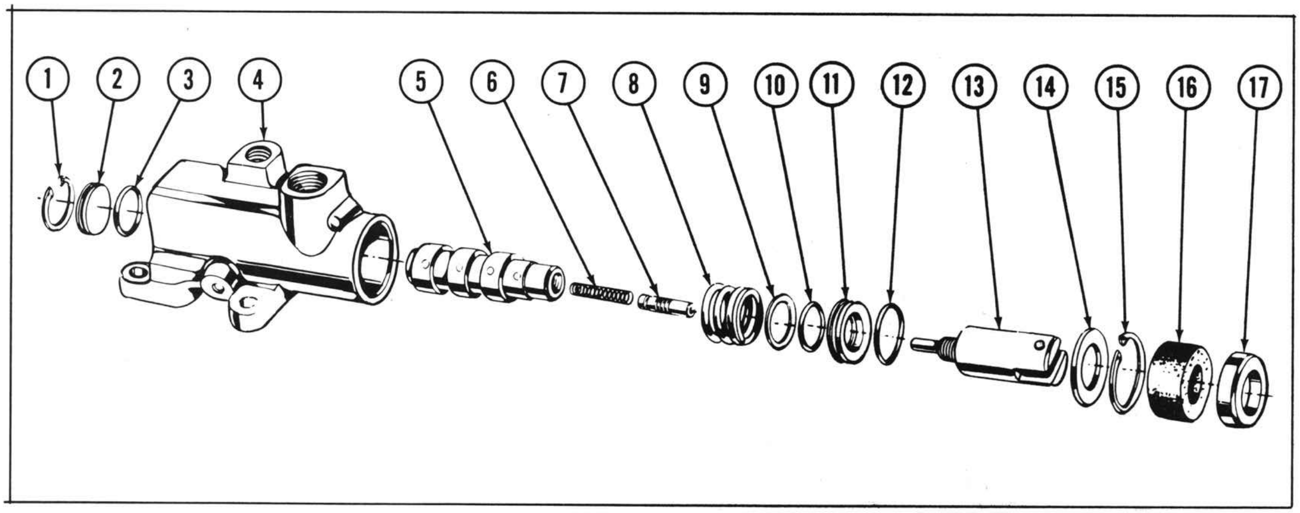


Fig. 3 - Power Steering Valve - Old Type

1. Snap Ring
2. End Plug
3. "O" Ring
4. Valve Body
5. Valve Outer Spool
6. Spring
7. Inner Spool
8. Spring
9. Thrust Washer
10. "O" Ring
11. Valve Guide
12. "O" Ring
13. Valve End Rod
14. Thrust Washer
15. Snap Ring
16. Dust Seal
17. Dust Seal Retainer

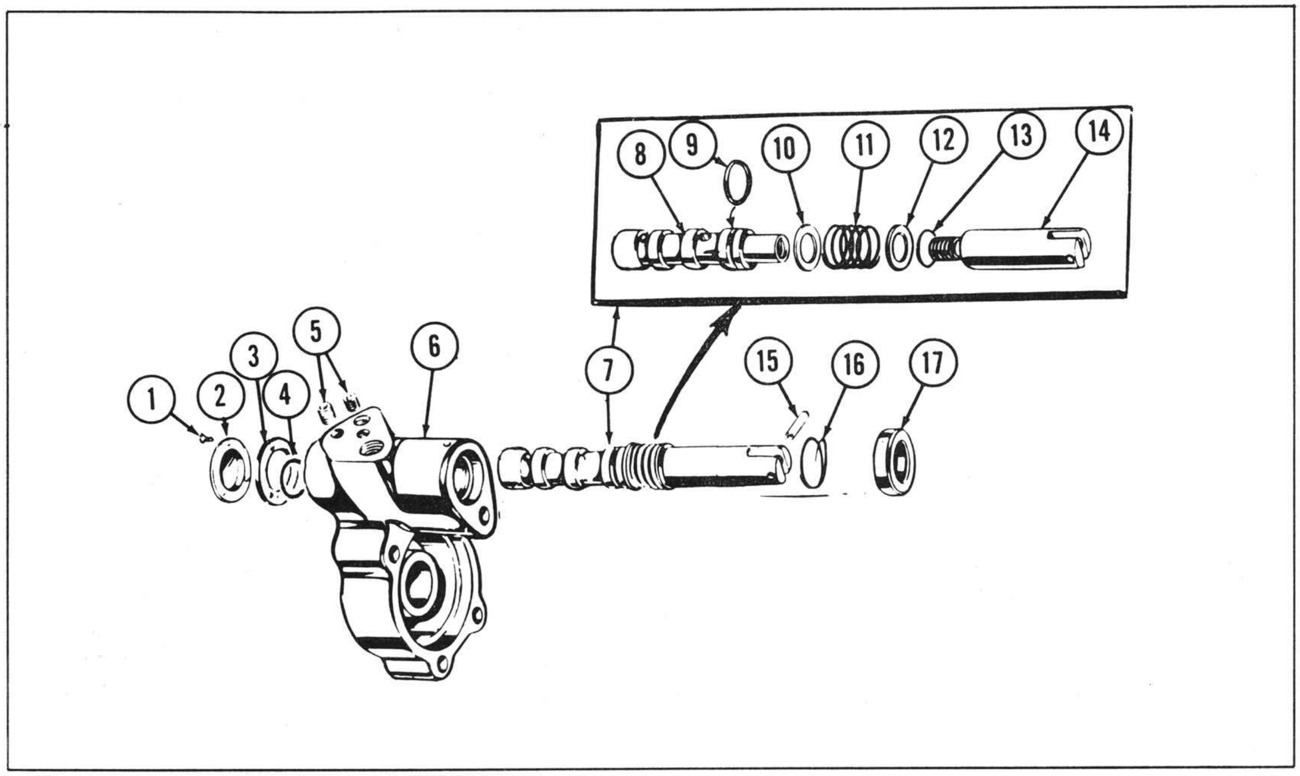


Fig. 4 - Power Steering Valve - New Type

1. Screw Nail
2. Body Cap
3. Dust Seal
4. "O" Ring
5. Allen Head Screws
6. Valve Body and Cylinder End
7. Spool Assembly
8. Valve Spool
9. "O" Ring
10. Retaining Washer
11. Spring
12. Retaining Washer
13. "O" Ring
14. Valve End Rod
15. Roll Pin
16. Spiral Snap Ring
17. Oil Seal

2. Push the valve spool out the end of the valve body.

3. Remove the spiral snap ring (No. 16) from the valve body and allow the washer (No. 12) the spring (No. 11) and the washer (No. 10) to fall from the valve body.

4. Remove the following "O" rings:

   a. Inner valve "O" ring (No. 4) from valve body (No. 6).

   b. Outer valve "O" ring (No. 9) from valve spool (No. 8).

   c. Passage tube "O" ring (No. 13) from valve end rod (No. 14).

INSPECTING AND SERVICING THE STEERING VALVES-ALL MODELS

Clean all parts thoroughly and renew any which show signs of wear and damage. Always use new "O" rings and gaskets.

During removal of the end cap, the screw nails may break. If this should happen, drill the nails out of the housing or rotate the end cap slightly, mark, and drill the housing. Always clean the valve body after drilling and use new nails during assembly.

ASSEMBLING AND INSTALLING THE VALVE

The following procedure is for assembling and installing valves on MF 50 tractors prior to Serial Number 516 788 and on MF 65 tractors prior to Serial Number 650 369. See Fig. 3.

1. Slide the spring (No. 6) and inner spool (No. 7) into the valve main spool (No. 5).

   NOTE: Slide the inner spool in so that the solid end (without drilled opening) enters the spool first.

2. Position spring (No. 8) spring thrust washer (No. 9) valve guide (No. 11) (with lubricated "O" rings (Nos. 10 and 12) in position) onto the valve.

   NOTE: Install the spring thrust washer so that the chamferred inside diameter is towards the spool. Install the valve guide so that the *wider land is next to the end rod. Securely tighten the valve end rod (No. 13).*

CAUTION: Whenever servicing the power steering valve, never turn the valve rod end in a counterclockwise direction as it may unscrew at this point.

3. Place a lubricated "O" ring (No. 3) on the shoulder in the valve body (No. 4) and install the end plug (No. 2) and snap ring (No. 1).

4. Slide the spool into the valve body followed by the guide thrust washer (No. 14) snap ring (No. 15) dust seal (No. 16) and dust cap (No. 17).

NOTE: Tap the dust cap in until approximately 1/16 inch protrudes past the end of the valve body.

5. Install new "O" rings between the valve body and the cylinder and bolt the valve to the cylinder. Tighten the bolts down evenly to a torque of 10 to 12 ft.-lbs.

6. Reconnect the linkage and install the cylinder in the tractor. See "Installing the Cylinder".

7. Fill, bleed and adjust the system as outlined in "Adjusting the System".

The following procedure is for assembling valves on MF 50 tractors after Serial Number 516 788 and on MF 65 tractors after Serial Number 650 369. See Fig. 4.

1. Replace all "O" rings with new. Lubricate the "O" rings before installing.

2. Lubricate the valve spool and body and install the valve spool from the spring end of the valve body.

3. Position the felt dust seal and install the valve body end cap (No. 2).

4. Position the valve spool so that a punch may be installed through the Allen head screw hole and into the spool.

5. Install washer (No. 10), spring (No. 11), washer (No. 12) and spiral snap ring (No. 16) into the valve body.

6. Screw the valve end rod (No. 14) into the valve spool.

NOTE: Whenever servicing the valve spool, never turn it in a counterclockwise direction because it may unscrew at this point.

7. Install the two Allen head screws (No. 5).

8. Reconnect linkage and install the cylinder in the tractor. See "Installing the Cylinder".

9. Fill, bleed and adjust the system as outlined in "Adjusting the System".

SERVICING THE POWER STEERING CYLINDERS

REMOVING THE CYLINDER-ALL MODELS

1. Remove the grill screens, grill bottom plate assembly and left side panel as outlined in Group IV, Section C, Part 3.

2. Disconnect the hoses at the pump and reservoir and turn the steering wheel in both directions to drain the oil from the cylinder.

3. Turn the steering wheel to the extreme left position and leave it there.

4. Remove the following (See Fig. 5):

   a. Cap screws holding the end bracket (No. 2) in position.

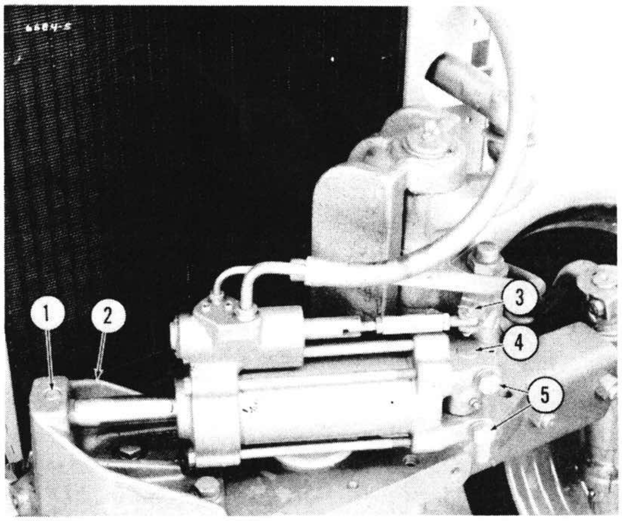


Fig. 5 - Removing the Cylinder

1. Cylinder to Support Pin
2. Support Bracket
3. End to Arm Pin Assembly
4. Cylinder to Arm Pin
5. Clamping Bolts

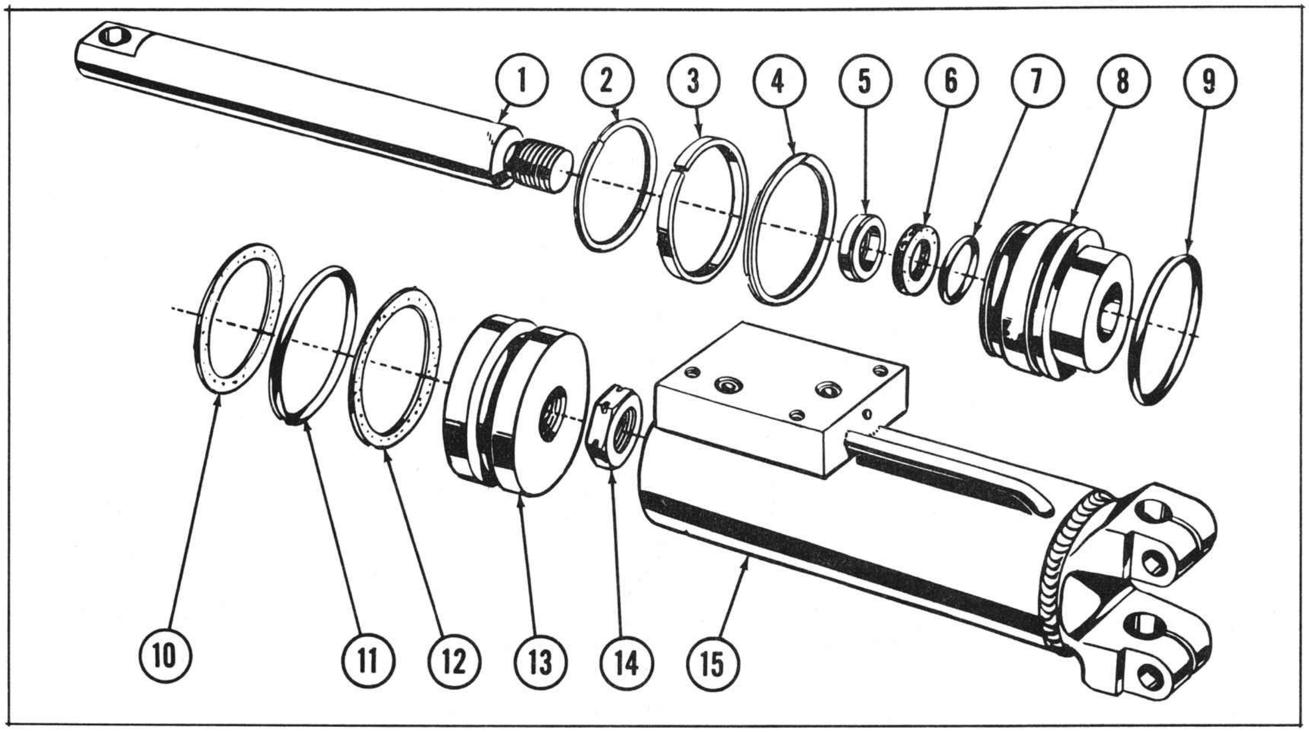


Fig. 6 - Cylinder Nomenclature - Old Type

1. Piston Rod
2. Spiral Snap Ring
3. Spacer
4. Spiral Snap Ring
5. Wiper
6. Back-Up Washer
7. "O" Ring
8. Tube Head
9. "O" Ring
10. Back-Up Washer
11. "O" Ring
12. Back-Up Washer
13. Piston
14. Lock Nut
15. Cylinder Tube Assembly

b. Cotter pin, washer and link connecting pin assembly (No. 3).

c. Cap screws (No. 5) clamping around pin (No. 4).

5. Drive out the pin (No. 4) connecting the cylinder to the pedestal.

NOTE: The pin (No. 4) will not clear the front support assembly unless the wheels are in the extreme left position.

6. Support the cylinder and bracket and remove pin (No. 1).

DISASSEMBLING THE CYLINDER

The following procedure is for cylinders on MF 50 tractors prior to Serial Number 516 788 and on MF 65 tractors prior to Serial Number 650 369. See Fig. 6.

1. Remove the bolts attaching the valve to the cylinder.

2. Remove the spiral snap ring (No. 2).

3. Push the tube head (No. 8) in.

4. Remove the spacer (No. 3) and spiral snap ring (No. 4).

5. Withdraw the piston and tube head from the tube.

6. Remove the following:

a. Tube head from the piston rod (No. 1).

b. "O" rings (Nos. 7, 9 and 11), back-up washers (Nos. 6, 10 and 12) and wiper (No. 5) from the piston and tube head.

c. Nut (No. 14) securing piston head (No. 13) to the rod and unscrew the piston head from the rod.

The following procedure is for cylinders on MF 50 tractors after tractor Serial Number 516 788 and on MF 65 tractors after tractor Serial Number 650 369 See Fig. 7.

1. Mount the cylinder tube end cap (No. 20) in a vise and remove the four bolts drawing the cylinder ends together.

2. Withdraw the hydraulic valve body and cylinder end (No. 1) from the tube and remove the oil tube (No. 5).

NOTE: Make sure that the spring (No. 2) behind the oil tube (No. 5) is not lost.

3. Pull the piston out of the cylinder. To remove the piston head from the rod, remove the lock nut (No. 14) and press the rod out of the piston.

4. Remove the tube (No. 17) from the cylinder end cap (No. 20).

5. Remove the following:

   a. "O" ring and four back-up washers from piston head and internal groove in valve body and end cap (No. 1).

   b. "O" ring and back-up washer from the tube (No. 17), cylinder end cap (No. 20) and each end of oil tube (No. 5).

   c. Wiper (No. 8) from recess in end of valve body and end cap.

INSPECTING AND SERVICING THE CYLINDERS-ALL MODELS

Clean all parts thoroughly and renew any which are damaged or show signs of wear.

Remove any paint present on the piston rod before assembling and installing the piston rod.

ASSEMBLING THE CYLINDER

The following procedure is for cylinders on MF 50 tractors prior to Serial Number 516 788 and on MF 65 tractors prior to Serial Number 650 369. See Fig. 6.

1. Screw the piston head onto the piston rod until it is tight against the tapered seat.

2. Tighten the lock nut against the piston head and stake with a center punch.

3. Install a lubricated back-up washer (No. 10), "O" ring (No. 11) and back-up washer (No. 12) onto the piston head.

4. Position a lubricated back-up washer and "O" ring in the internal groove of the tube head and a lubricated "O" ring in the external groove of the tube head. The back-up washer in the internal groove goes on the wiper side of the groove.

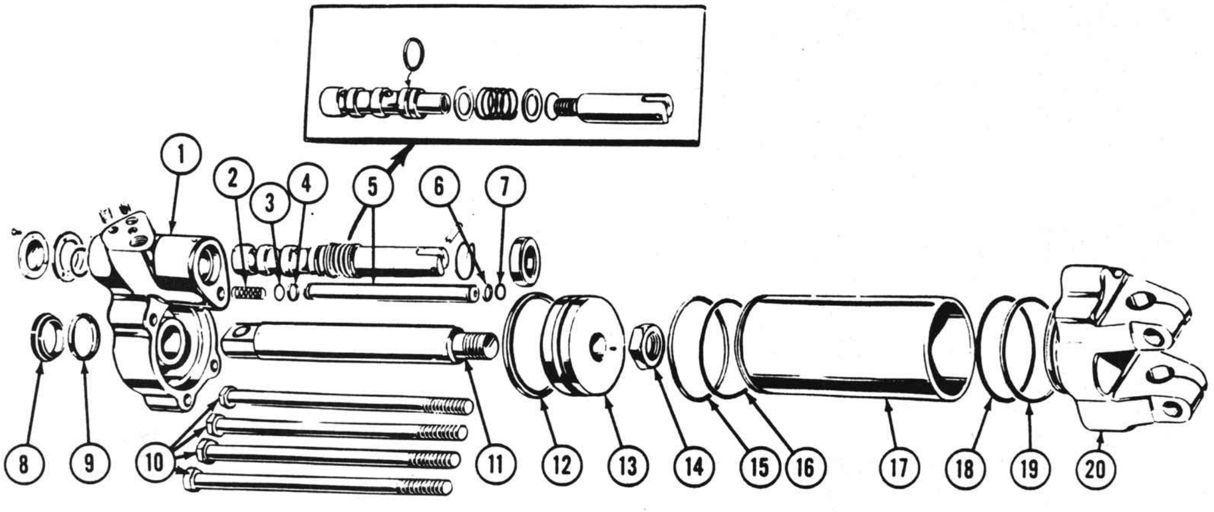


Fig. 7 - Cylinder Nomenclature - New Type

1. Valve Body and Cylinder End
2. Spring
3. "O" Ring
4. Back-Up Washer
5. Oil Passage Tube
6. Back-Up Washer
7. "O" Ring
8. Wiper
9. "O" Ring
10. Clamping Bolts
11. Piston Rod
12. "O" Ring
13. Piston
14. Lock Nut
15. "O" Ring
16. Back-Up Washer
17. Cylinder Tube
18. "O" Ring
19. Back-Up Washer
20. Cylinder End Cap

5. Install the wiper (No. 5) in the recess in the end of the tube head. The double lipped edge of the wiper enters the recess first. The tapered surface of the wiper goes against the rear tapered surface of the recess.

6. Insert the piston into the cylinder.

NOTE: Lubricate the piston and cylinder well before installation so that the "O" ring is not cut as it passes the snap ring groove in the cylinder.

7. Lubricate the inside and outside diameters of the tube head and install the tube head onto the lubricated piston rod.

NOTE: Use care during installation so that "O" rings and wiper is not damaged.

8. Install the heavy, large diameter spiral snap ring (No. 4) into the groove in the cylinder.

9. Pull on the piston rod until piston head forces the tube head against the snap ring.

10. Install split spacer (No. 3) and second spiral snap ring (No. 2).

The following procedure is for cylinders on MF 50 tractors after tractor Serial Number 516 788 and on MF 65 tractors after tractor Serial Number 650 369. See Fig. 7.

1. Lubricate and install the following:

   a. "O" ring and back-up washer on cylinder end cap (No. 20). Install "O" ring on tube side of back-up washer.

   b. "O" rings and back-up washers on each end of oil tube (No. 5). Install the "O" rings to the outside and the back-up washers to the center of the tube.

   c. "O" ring and four back-up washers in the internal groove in the valve body and end cap (No. 1). Install two back-up washers on each side of the "O" ring. Separate the gaps by 180°.

   d. "O" ring and four back-up washers on the piston head (No. 13). Install two back-up washers on each side of the "O" ring. Separate the gaps by 180°.

   e. "O" ring and back-up washer on cylinder tube (No. 17). Install back-up washer towards the center of the tube.

   f. Wiper (No. 8) in the recess in the end of the valve body end cap. The double lipped edge of the wiper enters the recess first. The tapered surface of the wiper goes against the rear tapered surface of the recess.

2. Press the piston head (No. 13) onto the piston rod (No. 11).

NOTE: The piston rod enters the chamferred side of the piston head first.

3. Tighten the nut securing the piston head on the rod securely and stake at four places.

4. Mount the end cap (No. 20) in a vise and lubricate the "O" ring sealing area of the end cap and the side of the chamferred end of the cylinder tube (No. 17).

5. Insert the lubricated piston into the chamferred end of the cylinder tube (piston rod entering first) and then install the cylinder tube onto the end cap.

6. Lubricate the oil tube ends, the sealing area of the oil tube openings, the "O" ring on the cylinder tube and the sealing area in the valve body end cap.

7. Position the oil tube (No. 5) into the end cap (No. 20).

8. Holding the oil tube spring (No. 2) in place, slide the valve body and end cap (No. 1) into position.

9. Install the four bolts and tighten them evenly to a torque of 15 to 20 ft.-lbs.

INSTALLING THE CYLINDER-ALL MODELS

1. Attach the bracket to the front support. Tighten the bolts to a torque of 47 to 53 ft.-lbs.

2. Position the cylinder and drive the pin (No. 1, Fig. 8) in from the lower side. Install the clamping cap screws and tighten to a torque of 47 to 53 ft.-lbs.

NOTE: The front wheels must be in the extreme left position.

3. Swing the cylinder into position and connect the piston rod to the bracket with pin (No. 1, Fig. 5) driven in from the top.

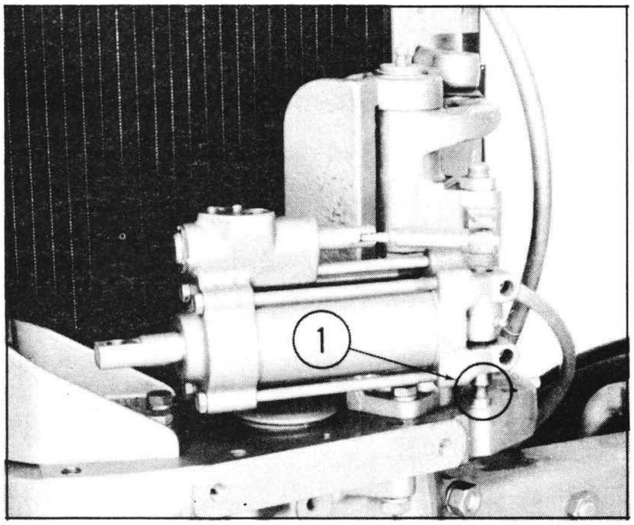


Fig. 8 - Installing the Cylinder

1. Cylinder to Arm Pin

4. Reconnect the linkage and hoses.

5. Fill, bleed and adjust the power steering system as outlined in "Adjusting the System".

6. Install the front grill panels, grill bottom plate assembly and left side panel as outlined in Group IV, Section C, Part 3.

SERVICING THE POWER STEERING PEDESTAL

REMOVING THE PEDESTAL

Remove the following:

1. Cylinder as outlined in "Removing the Cylinder".

2. Left hand radiator seal assembly. See Group IV, Section C, Part 3.

3. Drag link at the pedestal. The tapered bolt may be loosened in its bore by backing the nut off until it is flush with the end of the tapered bolt; strike the bolt and nut a sharp blow with a hammer; finish removing nut and lift out drag link.

4. Bolts attaching pedestal to front support assembly.

5. Bolt clamping steering arm (No. 17, Fig. 9) to lower spline on pedestal shaft.

DISASSEMBLING THE PEDESTAL

Before disassembling the pedestal, it is important that the pedestal shaft (No. 11), pedestal housing (No. 14) and valve connecting arm (No. 4) be marked as shown in Fig. 10, so that they may be properly "timed" during installation. Bottom the adjusting pin (No. 3) into the cylinder connecting arm (No. 8) before marking. Refer to Fig. 9.

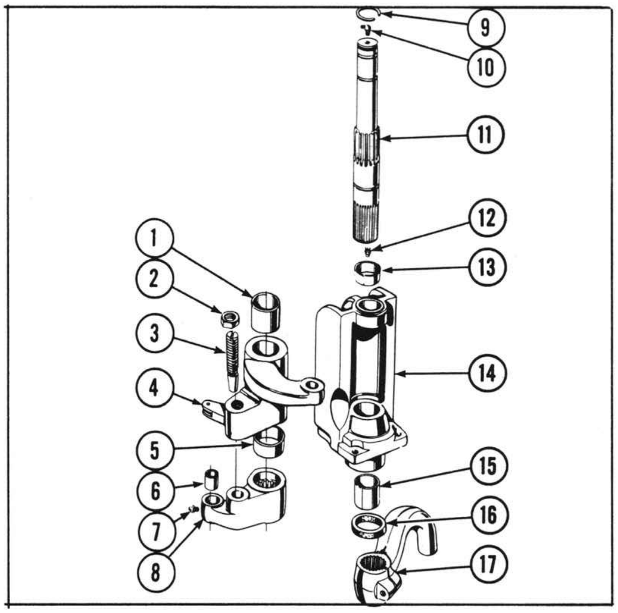


Fig. 9 - Pedestal Nomenclature

1. Bushing
2. Lock Nut
3. Adjusting Pin
4. Pedestal to Valve Arm
5. Bushing
6. Bushing
7. Grease Fitting
8. Pedestal to Cylinder Arm
9. Snap Ring
10. Grease Fitting
11. Pedestal Shaft
12. Grease Fitting
13. Bushing
14. Pedestal Housing
15. Bushing
16. Dust Seal
17. Steering Arm

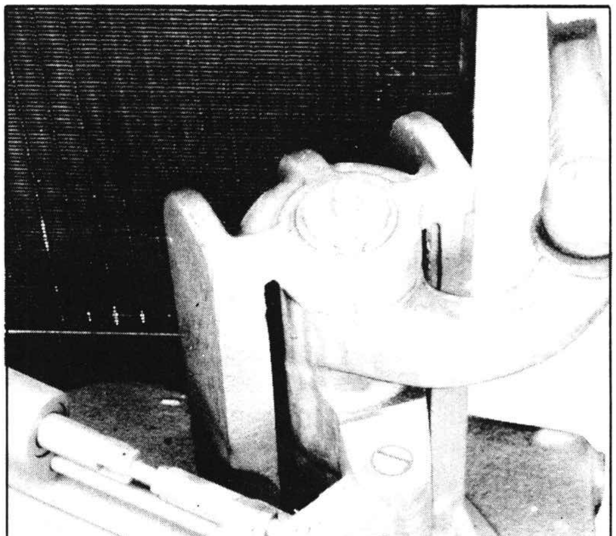


Fig. 10 - Preparing the Pedestal for Disassembly

1. Remove the dust seal (No. 16), snap ring (No. 9) and grease fitting (No. 10) from the pedestal shaft.

2. Mount the pedestal in a press and press the shaft out of the bottom of the pedestal housing.

NOTE: Use a press sleeve of sufficient size that the threads for the grease fitting are not damaged.

3. Once the shaft has been removed, the bushings in the pedestal housing (Nos. 13 and 15), cylinder connecting arm (No. 8) and valve connecting arm (No. 4) may be inspected and removed if necessary with step plate and driver.

4. To be removed, the adjusting pin (No. 3) must be screwed through and out of the bottom of the valve connecting arm (No. 4).

INSPECTING AND SERVICING THE POWER STEERING PEDESTAL

1. Clean all parts thoroughly and inspect them for wear and damage.

2. When replacing bushings, press in and line ream as follows: (See Fig. 9)

   a. Bushing (No. 13) press in until flush with both faces of the upper end of the pedestal. Bushing (No. 15) press in until flush with the recessed bottom of the pedestal. Line ream these two bushings at 90° to bottom mounting surface. Ream the lower bushing to a diameter of 1.8755 inch to 1.8765 inch and the upper bushing to a diameter of 1.5005 inch to 1.5015 inch.

   b. Bushing (No. 6) in the cylinder connecting arm (No. 8) must be pressed in until flush with both faces.

NOTE: Make sure hole in bushing is aligned with grease fitting opening.

Line Ream the bushing to a diameter of 0.7505 to 0.7508 diameter and at 90° to the top and bottom (as installed) faces of the connecting arm.

   c. Bushings (Nos. 1 and 5) in the valve connecting arm (No. 4) are to be pressed in flush to the top and bottom (as installed) faces. Once installed the bushings must be line reamed at 90° to these faces. Finished diameter is 1.5005 inch to 1.5015 inch.

ASSEMBLING THE POWER STEERING PEDESTAL

1. Install and ream bushings as outlined in "Inspecting and Servicing the Power Steering Pedestal".

2. If the adjusting screw pin (No. 2, Fig. 9) has been removed, replace it at this time.

3. Position the cylinder and valve connecting arms together so that the adjusting screw is aligned in its opening and place them in the pedestal housing.

4. Align the punch marks and install the pedestal shaft with a press.

NOTE: Remove the grease fitting (No. 12, Fig. 9) before pressing against the shaft.

5. Install the dust seal (No. 16) snap ring (No. 9) and the two grease fittings (Nos. 10 and 12, Fig. 9).

INSTALLING THE POWER STEERING PEDESTAL

1. Align the master spline of the pedestal shaft with the master spline of the steering arm. See Fig. 11.

NOTE: Depending upon the application, the steering arm may look different. Check the Tractor Parts Book.

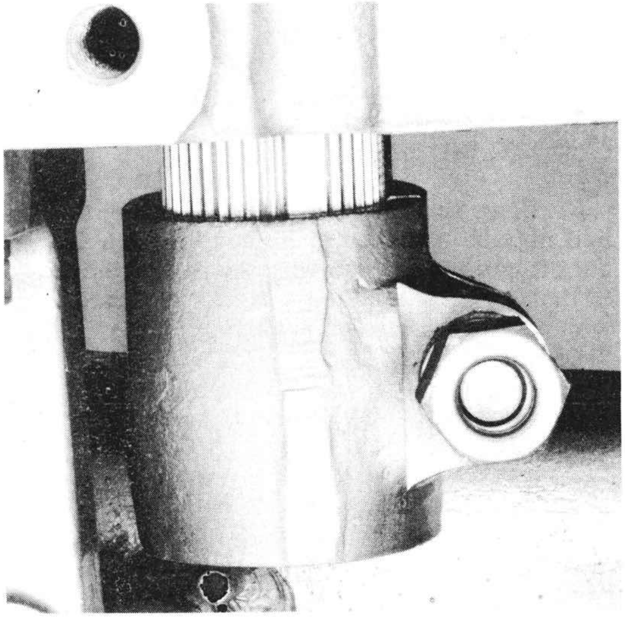


Fig. 11 - Pedestal Shaft Master Spline

2. Slide the housing into position on the front support, entering into the steering arm at the same time as shown in Fig. 12.

NOTE: Tighten the bolts to a torque of 47 to 53 ft.-lbs.

3. Lift the steering arm up tight to the pedestal bottom and tighten the clamping bolt to a torque of 33 to 38 ft.-lbs.

4. Attach the drag link to the valve connecting arm.

5. Install the left radiator seal assembly. See Group IV, Section C, Part 3.

6. Install the cylinder as outlined in "Installing the Cylinder".

ADJUSTING THE POWER STEERING

1. Check the oil level in the reservoir. Use only automatic transmission oil, type A, to raise the oil level to the full (F) mark 1/2 inch over the filter element (the entire system has a capacity of approximately 3-1/3 U.S. pints).

NOTE: If the system has been drained, fill the reservoir; start the engine and turn the front wheels in both directions; stop the engine and recheck the oil level.

2. Check and adjust steering gear if necessary, as outlined in Group IV, Section A, Part 6.

3. Place wheels in straight forward position.

4. With the engine running at 1500 RPM, tighten the valve adjusting pin (No. 2, Fig. 9) until it bottoms.

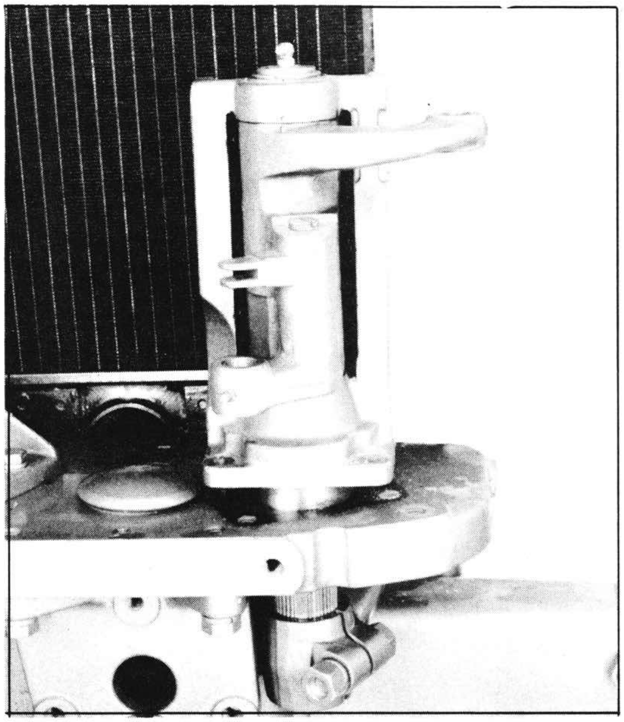


Fig. 12 - Installing the Pedestal Assembly

5. Adjust control valve linkage (No. 2, Fig. 2) so that pin (No. 1, Fig. 2) can be inserted freely.

6. Back off adjusting pin (No. 2, Fig. 9) seven turns and try to turn the steering wheel.

7. Continue adjusting the control valve linkage (No. 2, Fig. 2) until the wheel can be turned with the same amount of effort, in both directions and the relief valve can be forced to operate at each extreme position. Tighten lock nut on adjusting pin (No. 2, Fig. 2).

NOTE: If more ease of steering is desired, back out the adjusting pin an additional 3 or 4 turns. Do not back out the adjusting pin more than 12 full turns.

GROUP IV — SECTION B — PART 4

FRONT WHEEL AND HUB ASSEMBLIES
35, 50 & 65 (MF & TO) TRACTORS

INDEX

Page

Servicing the Wheel and Hub Assemblies
for Twin and Wide Front Axle Models 2

Servicing the Wheel and Hub Assembly
for Single Front Wheel Axle Models 3

Similarities exist between various wheel and hub assemblies that allow the servicing procedures involving several assemblies to be discussed as one group.

Front wheel and hub assemblies have interchange features that permit some exchange of parts and assemblies between the 35, 50 and 65 (MF & TO) tractors as well as permitting an exchange between several front axle assemblies. However, the interchange features are limited to the combinations as discussed in this text.

Hub assemblies for the following combinations are interchangeable within this group inclusively:

1. The 35 (MF & TO) tractor front axle.
2. The MF 50 tractor equipped with Utility, Hi-Arch, or Row Crop Twin Front Axle.
3. The MF 65 tractor equipped with Standard, Hi-Arch, or Row Crop Twin Front Axle.

Hub assemblies may also be interchanged within another group of combinations which are listed as follows:

1. The MF 50 tractor equipped with Row Crop Single Wheel Front Axle.
2. The MF 65 tractor equipped with Row Crop Single Wheel Front Axle.

No interchangeable features are provided for hub assemblies required for the combinations listed within the group as follows:

1. The MF 50 tractor equipped with a Multi-Purpose Front Axle.
2. The MF 65 tractor equipped with a Utility Front Axle.

Wheel assemblies may be interchanged within certain limitations. Refer to the Tractor Parts Book.

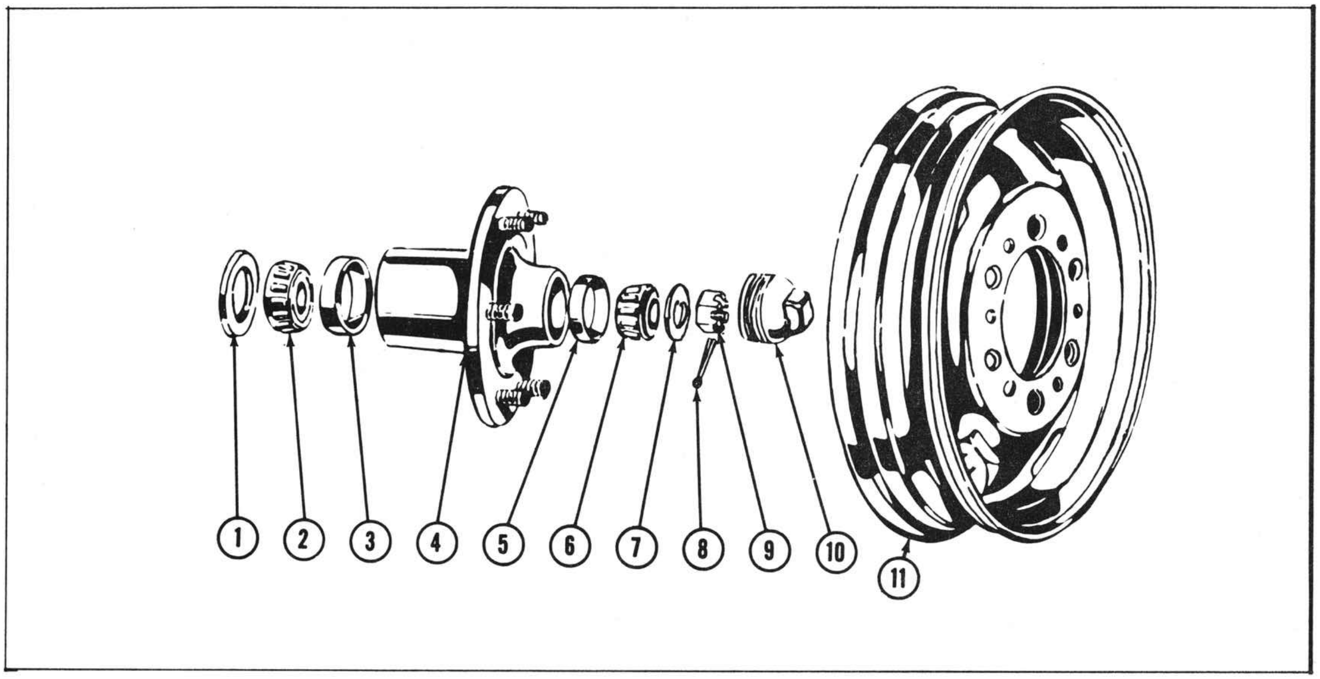


Fig. 1 – MF & TO 35 (Front Axle); MF 50 (Utility, Hi-Arch, Row Crop Twin Front Axle); MF 65 (Standard, Hi-Arch, Row Crop Twin Front Axle) Front Wheel and Hub Assembly Nomenclature

1. Dust Seal
2. Inner Bearing Cone
3. Inner Bearing Cup
4. Hub
5. Outer Bearing Cup
6. Outer Bearing Cone
7. Retainer Washer
8. Cotter Pin
9. Castellated Nut
10. Hub Cap
11. Wheel

SERVICING THE FRONT WHEEL AND HUB ASSEMBLIES

35 (MF & TO) front axle; MF 50 Utility, Multi-Purpose, Hi-Arch or Row Crop Twin; MF 65 Utility, Standard, Hi-Arch or Row Crop Twin Front Axles.

REMOVING AND DISASSEMBLING

Slightly loosen lug nuts, and hub cap, then raise the tractor until front wheels clear the ground.

> *NOTE: Front axles having a center member may be stabilized by placing wedges between center member and support casting.*

REMOVE: (Refer to Fig. 1)
1. Lug nuts.
2 Wheel, No. 11.
3. Hub cap, No. 10
4. Cotter pin, and castellated nut, No. 9.
5. Bearing retainer washer, No. 7, the outer bearing cone, No. 6, and the hub, by pulling the hub off the stub axle.

> *NOTE: The bearing cups, Nos. 3 and 5, are pressed into the hub.*

6. Inner bearing, No. 2, and dust seal, No. 1.

INSPECTING

Clean all parts thoroughly and inspect for wear or damage.

ASSEMBLING AND INSTALLING

INSTALL:

1. Bearing cups, Nos. 3 and 5 (if they have been removed from hub) to the hub by pressing carefully with a suitable press.

Thoroughly lubricate the bearings and bearing cups with a good grade of wheel bearing grease.

> *NOTE: It is important to pack the area between the inner bearing and the seal with grease.*

2. Inner bearing, No. 2, into its respective place in the hub, No. 4, and apply more lubricant.
3. Dust seal, No. 1.
4. Hub, containing the 2 bearing cups and inner bearing, to the stub axle.
5. Outer bearing, No. 6, to the hub.
6. Bearing retainer washer, No. 7, after the bearing.

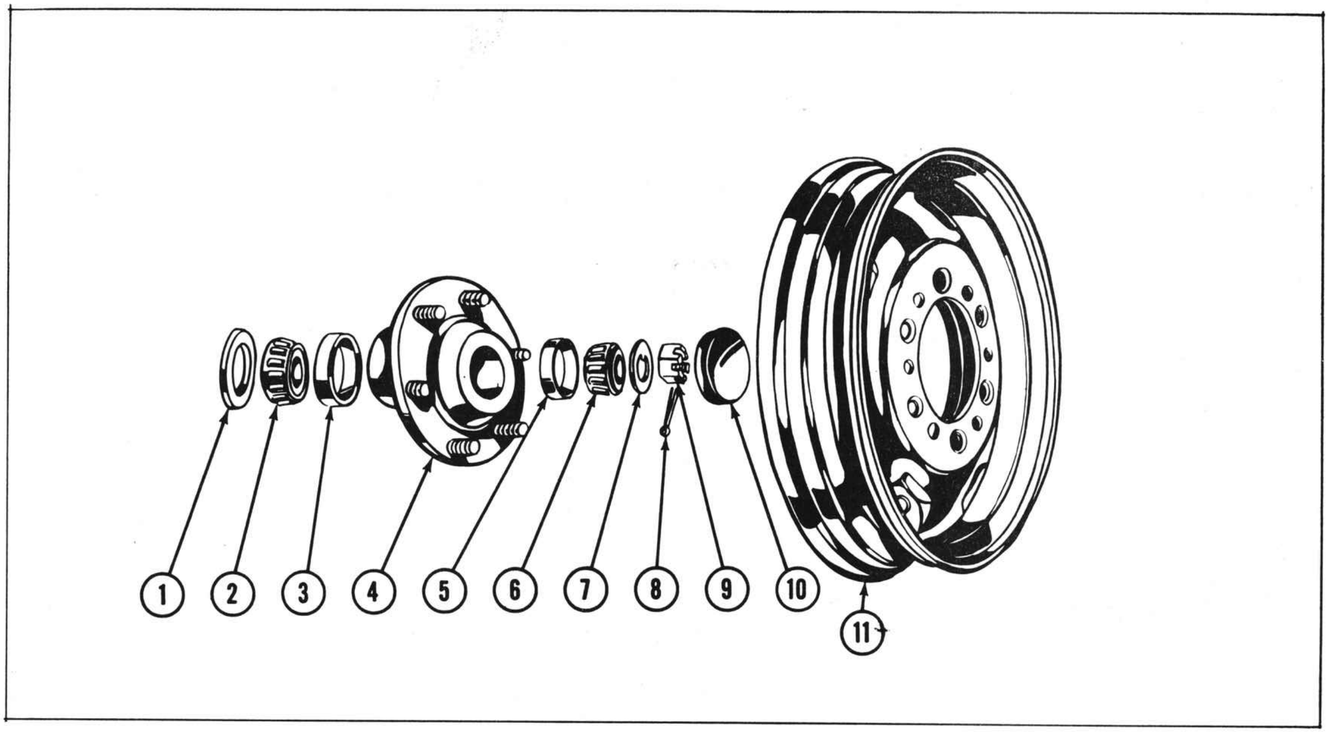


Fig. 2 – MF 65 (Utility Front Axle) Front Wheel and Hub Assembly Nomenclature

1. Dust Seal
2. Inner Bearing Cone
3. Inner Bearing Cup
4. Hub
5. Outer Bearing Cup
6. Outer Bearing Cone
7. Retainer Washer
8. Cotter Pin
9. Castellated Nut
10. Hub Cap
11. Wheel

7. Castellated nut, No 9, to the stub axle.

NOTE: Exercise care to keep the assembly free of grit.

8. Wheel, No. 11, to the hub, using the lug nuts.

NOTE: Adjust the wheel bearings by tightening the castellated nut until the bearings seat (the wheel will become too tight to turn, thus indicating that the bearing is seated). Then back off on the nut until there is a slight drag. Secure with cotter pin.

Securely tighten the lug nuts and install hub cap.

SERVICING FRONT WHEEL AND HUB ASSEMBLIES

MF 50 and 65 ROW CROP SINGLE FRONT AXLE MODELS

REMOVING

Support the tractor with front wheel touching the ground, but with weight of tractor relieved from the wheel.

REMOVE: (Refer to Fig. 3)

1. Cotter pin from L.H. side of front axle shaft.
2. L.H. castellated nut gradually from the axle shaft, and working a tool between the spacers Nos. 2 and 14, and the axle fork to free the spacers so they will be retained with the hub assembly, as the axle shaft and the wheel is removed.
3. Front axle shaft from RH side, keeping the wheel in a centered position which will allow the shaft to move without damage.
4. Wheel and hub assembly should roll out once the shaft has been removed.
5. L.H. & R.H. eccentric washers from the fork.

DISASSEMBLING

CAUTION: Deflate the tire before attempting disassembly of this wheel.

Refer to Fig. 3, and disassemble:

1. R.H. & L.H. spacers, Nos. 2 and 14.
2. R.H. & L.H. washer retaining cups, Nos. 5 and 11, by prying around them evenly from the hub, No. 8.
3. Four felt washers, from the retaining cups.

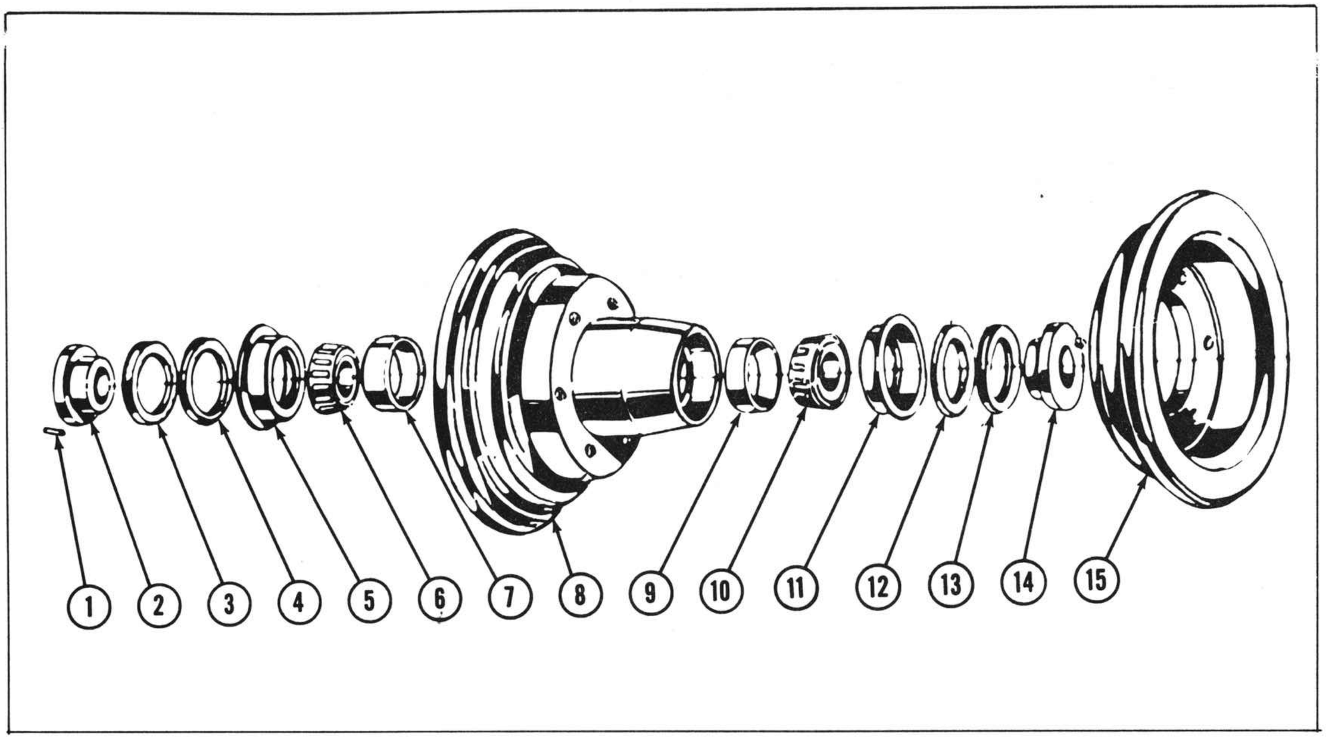


Fig. 3 – MF 50 and MF 65 Single Front Wheel and Hub Assembly Nomenclature

1. Locating Pin
2. Spacer
3. Felt Washer
4. Felt Washer
5. Felt Washer Cup
6. Bearing Cone
7. Bearing Cup
8. Hub
9. Bearing Cup
10. Bearing Cone
11. Felt Washer Cup
12. Felt Washer
13. Felt Washer
14. Spacer
15. Rim

4. R.H. & L.H. bearing cones, Nos. 6 and 10, from the hub.
5. Six bolts securing the rim to hub.
6. Tire after separating the rim, No. 15from hub, No. 8.

INSPECTION

Clean all parts thoroughly and inspect for wear or damage.

ASSEMBLING

Refer to Fig. 3, and install:

1. R.H. & L.H. bearing cups, Nos. 7 & 9, to the hub (if they have been removed). Press in place with a suitable press.
2. Tire to the hub side of rim, No. 8, and assembling other rim half, No. 15, to hub with six bolts (The tire can now be inflated.)

> *NOTE: Pack the bearing and bearing cups with a good grade of wheel bearing grease.*

3. R.H. & L.H. bearing cones, Nos. 6 & 10, to the hub - wipe off excess grease.

4. R.H. & L.H. washer retaining cups, Nos. 5 & 11, to the hub by pressing evenly all around the edges.

5. Four felt washers into the reatining cups. (2 washers in each cup).

6. R.H. & L.H. spacers, Nos. 2 & 14, to the retaining cups.

INSTALLING

Position the wheel to line up with holes in fork, and position spacer line-up pins, No. 1, Fig. 3, to align with pin holes in fork, then install:

1. R.H. eccentric washer in place on fork.

2. Front axle shaft from R.H. side, through eccentric washer, R.H. side of fork, hub assembly, and L.H. side of fork.

3. L.H. eccentric washer.

4. Castellated nut and tighten to preload the bearings then back-off until wheel will rotate with a slight drag.

5. Secure nut with cotter pin.

GROUP IV — SECTION C — PART 3

PART 3. INSTRUMENT PANEL AND SHEET METAL

MF 65 TRACTOR

INDEX

Page
Servicing the Grill Assembly 1
Servicing the Hood and Side Panels 2
Servicing the Fender Assemblies 2
Servicing the Seat Assembly 5
Servicing the Instrument Panel and
Battery Carrier 5

This Part shall cover the removal of the larger, and more important, sheet metal items. Along with this, the removal and installation of the instrument panel and battery carrier is also covered.

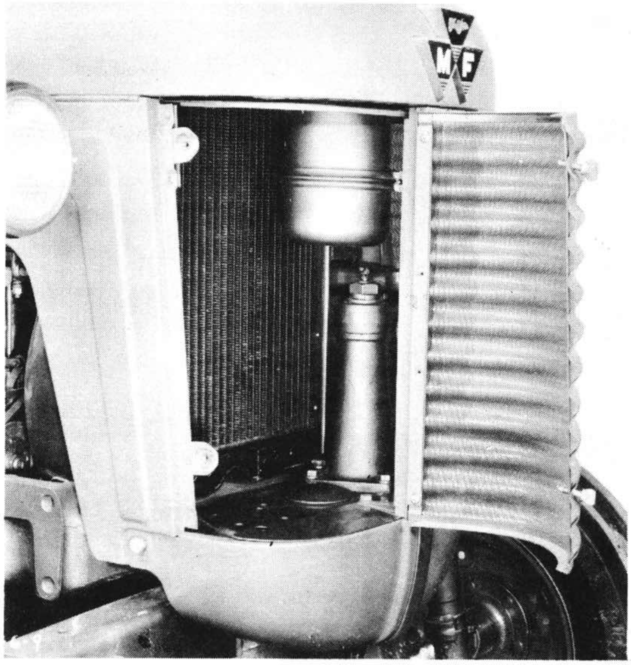


Fig. 1 – Opening Right Grill Door

The procedures listed are not specific, but will aid in the removal and installation of the various sheet metal items of all MF 65 tractors (gas, Diesel or L.P.G.).

SERVICING THE GRILL ASSEMBLY

The grill consists of two corrugated panels of 18 gauge perforated steel with 1/16 inch diameter staggered holes.

REMOVING THE GRILL ASSEMBLY

The right side of the grill is hinged to the center bar and secured in position by two thumb screws. Loosening the thumb screws allows this side of the grill to swing open, as shown in Fig. 1.

The left side of the grill is held in position by two pins at the bottom and two at the top of the grill. To remove the left grill section, open the hood panel and lift the grill section off the pins, as shown in Fig. 2.

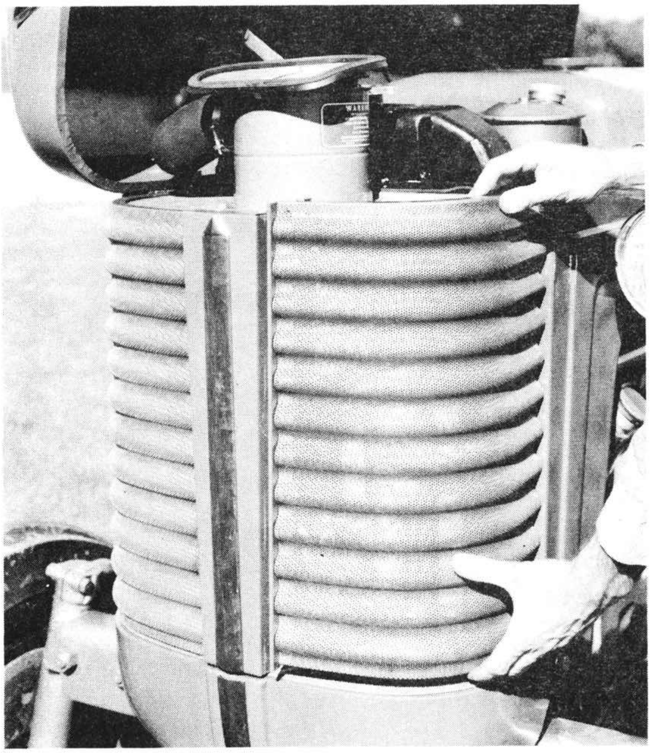


Fig. 2 – Removing Left Grill Door

To remove the entire grill assembly (see Figs. 3 and 4):

1. Loosen the thumb screws that secure the right side of the grill in position.

2. Lift the left side of the grill out as described above.

3. Remove the two bolts at the top and the two bolts at the bottom of the center bar and lift the grill assembly out.

INSTALLING THE GRILL ASSEMBLY

Install the grill assembly by reversing the steps under "Removing the Grill Assembly".

SERVICING THE HOOD AND SIDE PANELS

REMOVING THE HOOD AND SIDE PANELS

The hood and right hand side panel can be removed as a single unit from the tractor. See Figs. 3 and 4.

1. If the tractor headlights are mounted on the hood side panels, disconnect the right hand headlight electrical connection.

2. Unlatch and open the hood on the left side of the tractor.

3. Open the right side of the grill.

4. Remove the two sheet metal screws in the upper right hand corner of the side panel.

5. Remove the bolt in the lower right hand corner of the side panel.

6. Remove the three sheet metal screws which join the side panel to the instrument panel.

7. Lift the hood and side panel from the tractor.

To remove the left hand side panel:

1. If the tractor headlights are mounted on the hood side panels, disconnect the left hand headlight electrical connection.

2. Unlatch and open the hood on the left side of the tractor.

3. Lift out the left section of the grill.

4. Remove the two sheet metal screws in the upper left hand corner of the side panel.

5. Remove the bolt in the lower left hand corner of the side panel.

6. Remove the three sheet metal screws which join the side panel to the instrument panel.

7. Lift the side panel from the tractor.

INSTALLING THE HOOD AND SIDE PANELS

To install the hood and side panels, reverse the steps under "Removing the Hood and Side Panels".

SERVICING THE FENDER ASSEMBLIES

REMOVING THE FENDERS

To remove the fenders from the tractor: (See Figs 5 and 6):

1. Disconnect the electrical wiring from the lights that are mounted on the fender.

2. Remove the two bolts which secure the fender to the axle housing.

3. Lift the fender from the tractor.

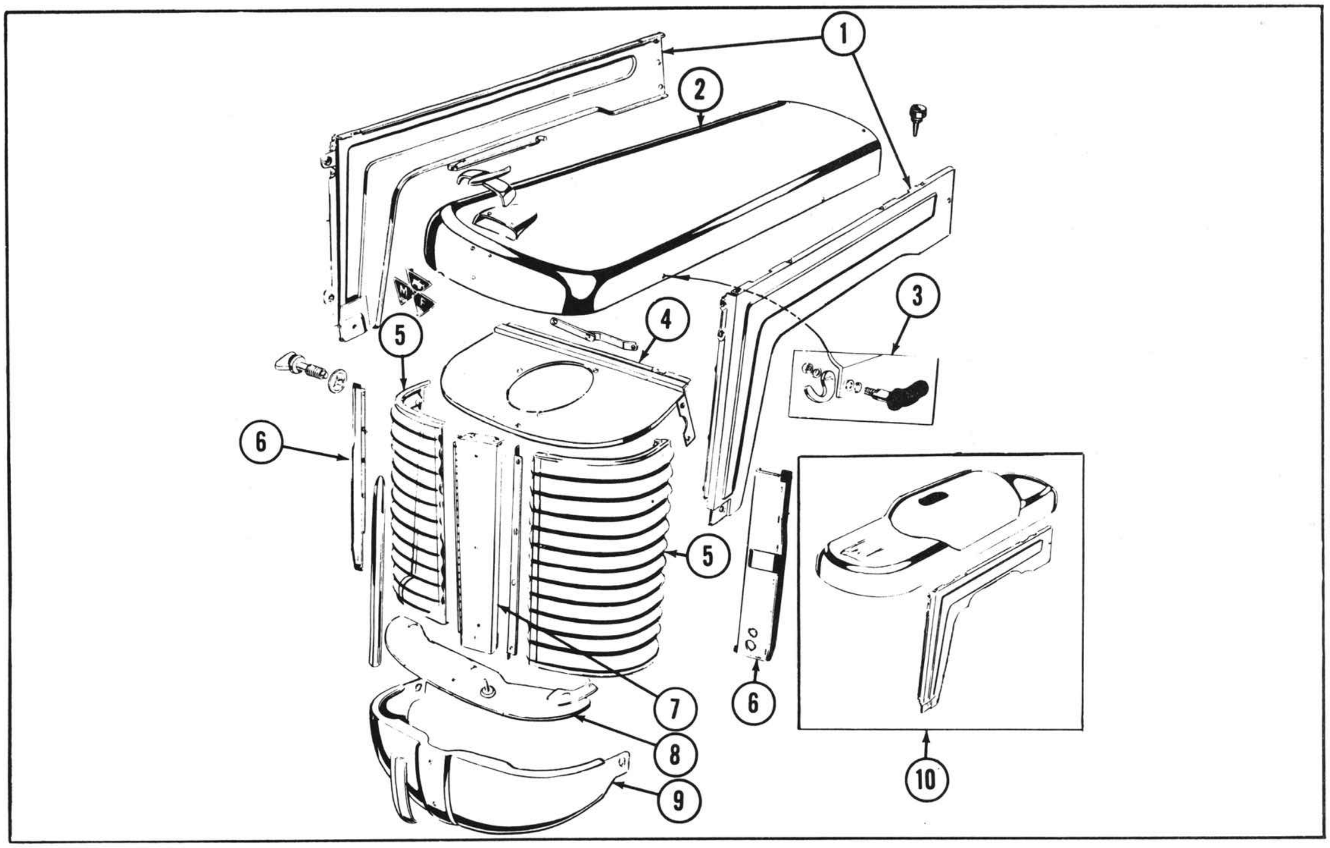


Fig. 3 – Grill, Hood and Side Panel Nomenclature

1. Side Panel
2. Hood
3. Latch Assembly
4. Upper Plate Assembly
5. Grill Assembly
6. Radiator Seal Assembly
7. Center Bar Assembly
8. Bottom Plate Assembly
9. Lower Grill Panel
10. L.P.G. Hood and Side Panel Assembly

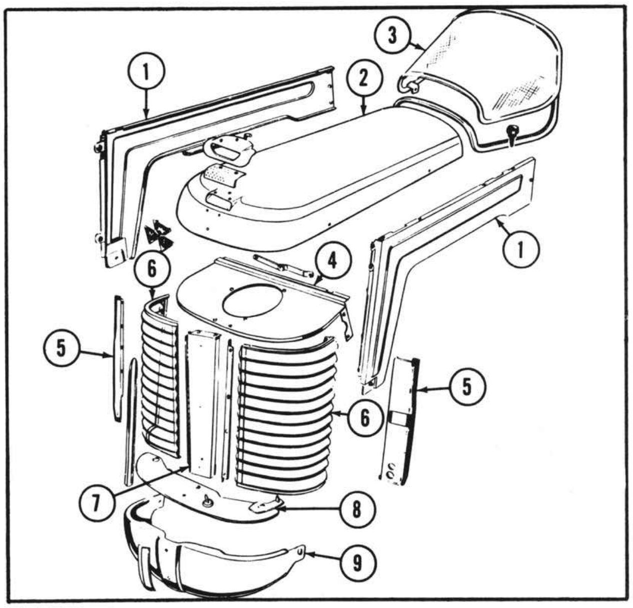


Fig. 4 – Orchard Type Nomenclature

1. Side Panel
2. Hood
3. Cowl Guard
4. Upper Plate
5. Radiator Seal
6. Grill
7. Center Bar
8. Lower Plate
9. Lower Grill Panel

INSTALLING THE FENDERS

To install the fender assemblies (No. 1) onto the tractor, reverse the steps under "Removing the Fenders". Fender riser assemblies (No. 2, Fig. 6) are used on Hi-Clearance tractors.

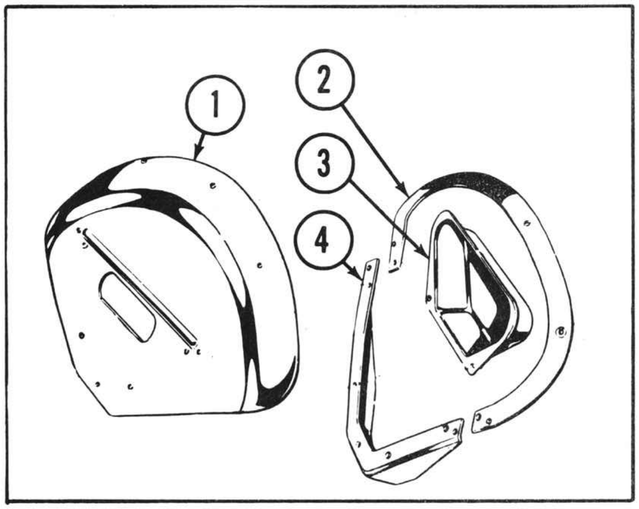


Fig. 5 – Fender Assembly Nomenclature

1. Fender
2. Upper Support
3. Tool Box
4. Lower Support

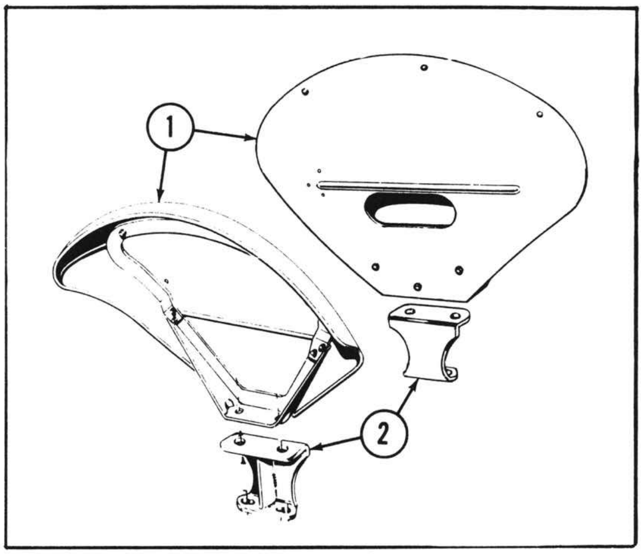


Fig. 6 – Hi-Clearance Fender Assemblies

1. Fender Assemblies 2. Riser Assemblies

REMOVING ORCHARD TYPE FENDERS

The procedure which follows is to completely remove the fenders and attaching parts. When removing only the fender, proceed only through Step 4.

Support the fender and remove the following (See Fig. 7):

1. Bolts attaching fender brace (No. 2) to axle pad and fender to the fender support (No. 6).

2. Disconnect wiring when present.

3. Bolt (No. 7) attaching fender assembly, step plate (No. 8), spacer (No. 9) and extension support assembly (No. 10) together.

4. Lift off the fender assembly (Nos. 1, 2, 3 and 4).

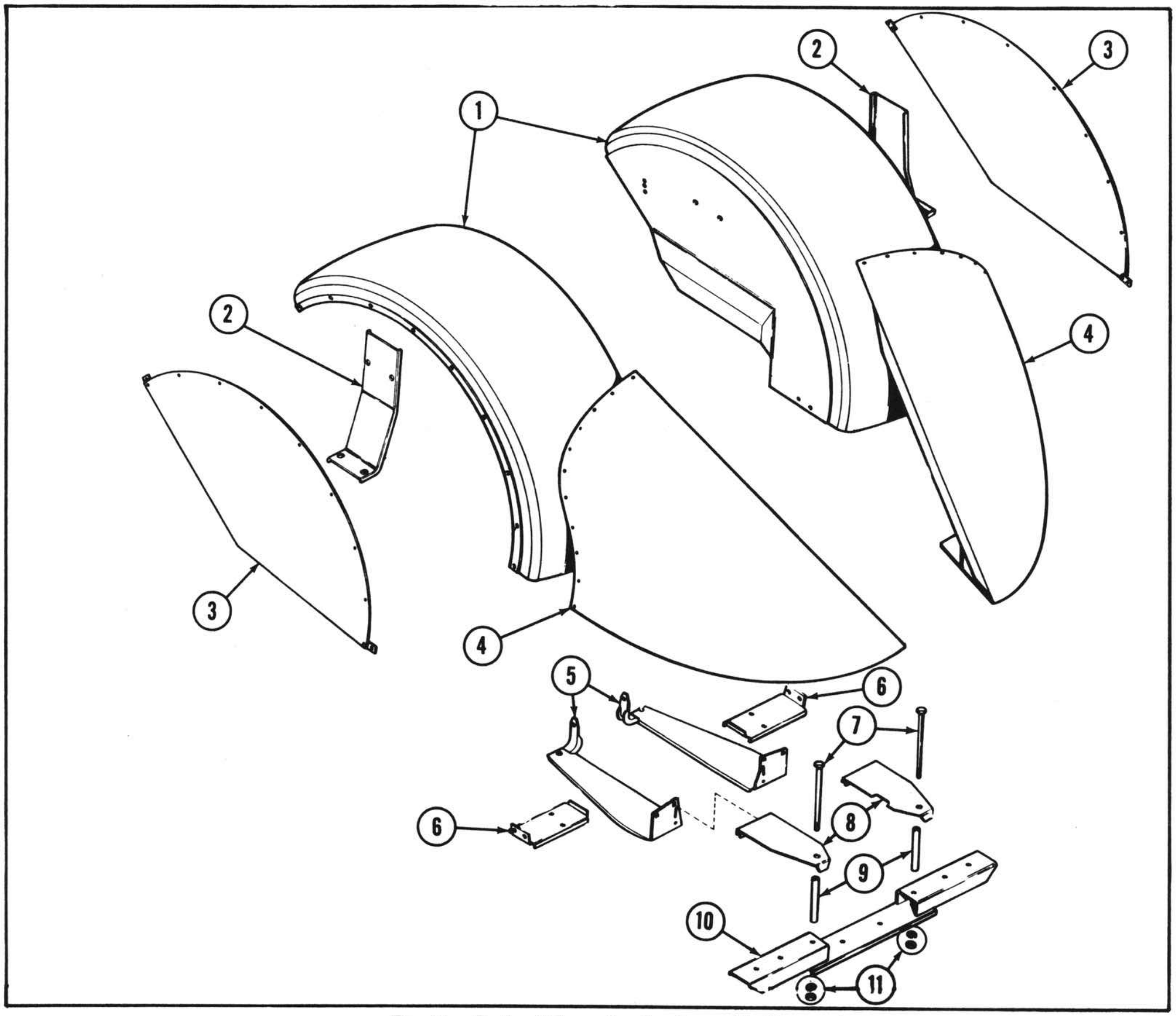


Fig. 7 – Orchard Type Fender Assembly Nomenclature

1. Fender
2. Fender Brace
3. Fender Skirt
4. Fender Extension
5. Platform Assembly
6. Fender Support
7. Bolt
8. Step Plate
9. Spacer
10. Extension Support
11. Nut and Lock Washer

5. Bolts attaching fender support (No. 6) to platform (No. 5) and bolts attaching extension support assembly (No. 10) to underside of tractor.

INSTALLING THE ORCHARD TYPE FENDERS

Install the orchard type fenders by reversing the removal procedure.

SERVICING THE SEAT ASSEMBLY

The bucket type seat, with foam rubber cushion and back rest, is mounted by a double hinge on a support bracket.

The double hinge allows the seat to be tilted back to give more leg room to the operator. The seat can be adjusted forward and back in any of three positons.

Once removed, disassembly of the seat and support bracket assembly is evident.

REMOVING THE SEAT ASSEMBLY

To remove the seat assembly from the tractor, remove the nuts from the two studs which secure the seat to the lift cover and lift the seat assembly from the tractor.

INSTALLING THE SEAT ASSEMBLY

To install the seat on the tractor, position the seat onto the studs in the lift cover and tighten the nuts onto the studs.

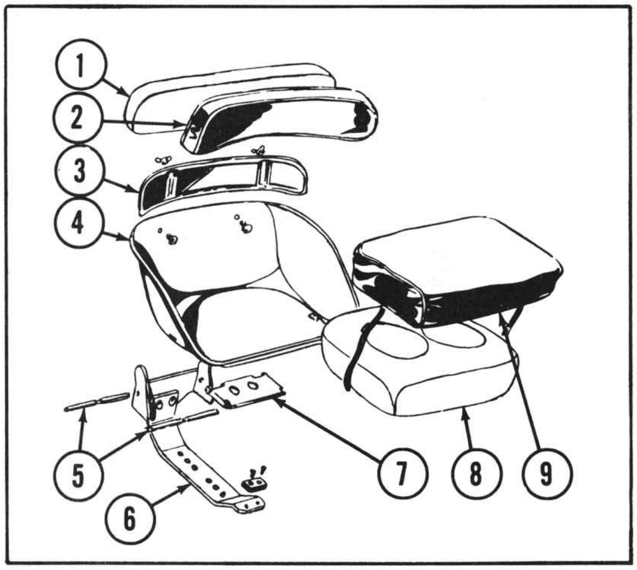


Fig. 8 — Seat Assembly Nomenclature

1. Back Rest Cushion
2. Back Rest Cover
3. Back Rest Support
4. Seat
5. Hinge Pin
6. Mounting Bracket
7. Hinge Link
8. Seat Cushion
9. Seat Cover

SERVICING THE INSTRUMENT PANEL AND BATTERY CARRIER

REMOVING THE INSTRUMENT PANEL

To remove the lower instrument panel, remove or disconnect the following:

1. Key, switch retaining nut and index plate,

2. Light switch knob and switch retaining nut.

3. Three sheet metal screws on both sides of the lower instrument panel.

4. Lower instrument panel can now be removed from the tractor.

To remove the upper instrument panel, remove or disconnect the following:

1. Hood and side panels as outlined in "Removing the Hood and Side Panels".

2. Lower instrument panel as previously described.

3. Steering wheel as described in Group IV, Section A, Part 6.

4. Throttle linkage.

5. Flexible shaft that drives the tractormeter at the back of the tractormeter.

6. Oil pressure line to the oil pressure gauge at the back of the gauge.

7. Water temperature sending unit from the water pump housing. Work the sending unit and cable free of the engine.

> *NOTE: Use care that the cable between the water temperature gauge and the temperature sending unit is neither kinked or stretched when the instrument panel is removed from the tractor.*

8. The wires connected to the Ampere meter, oil pressure gauge and fuel gauge.

9. Four bolts, along the bottom edge of the instrument panel, that secure the panel to the battery platform.

10. 'The upper instrument panel can now be removed from the tractor.

NOTE: Use care that the line between the water temperature gauge and the temperature sending unit is neither kinked or stretched when the instrument panel is removed from the tractor.

INSTALLING THE INSTRUMENT PANEL

Install the instrument panel by reversing the steps under "Removing the Instrument Panel."

REMOVING THE BATTERY CARRIER

1. Remove the battery carrier and instrument panel from the tractor as a unit.

2. Take out the bolts attaching the battery carrier to the instrument panel; separate the battery carrier and instrument panel and disconnect wires running to the voltage regulator.

3. If the carrier is to be discarded, remove the serviceable parts attached to the carrier.

INSTALLING THE BATTERY CARRIER

Install the battery carrier by reversing the removal procedure.

REMOVING THE BATTERY CARRIER AND INSTRUMENT PANEL AS A UNIT

1. From all models remove and/or proceed as follows:

a. Hood and side panels as outlined in Group IV, Section C, Part 3.

b. Drain the radiator and remove the temperature gauge sending unit from the thermostat housing.

NOTE: Work the cable and sending unit free from the engine. Do not kink or place short bends in the cable.

c. The battery cables from the battery. Remove the battery.

d. Wires from the starter, generator, and neutral safety switch.

e. Wires from headlights and tail lights where present.

f. Oil pressure gauge line from engine.

g. Shut off the fuel and remove the lines to the fuel tank. Loosen the front bolts of the fuel tank and remove the rear fuel tank support bolts. Block up the rear of the fuel tank between the rocker arm cover and the fuel tank.

h. The steering wheel, woodruff key, felt washer, spring, chrome cap, and rubber dust seal. See Group IV, Section A, Part 6.

2. On Diesel models continue by removing the following:

a. Fuel lines between: the primary fuel pump and the primary filter. Primary filter and the secondary filter. Secondary filter and the injection pump. Bleed-off lines from the top of the secondary filter.

b. Throttle control rod at the front, left, lower corner.

c. Fuel shut-off rod at the injection pump.

d. Wire to cold starting aid.

e. Tractormeter drive cable from end of camshaft.

2. On gas models continue by removing the following:

a. Wires from the coil.

b. Throttle control rod at the rear ball joint.

c. Choke rod at the carburetor.

d. Tractormeter from the generator.

3. Remove the bolts attaching the battery carrier and instrument panel to the tractor engine and steering gear housing; lift off the battery carrier and instrument panel as a unit.

INSTALLING THE BATTERY CARRIER AND INSTRUMENT PANEL AS A UNIT

Install the instrument panel and battery carrier as a unit by reversing the removal procedure.

PART 1—G-176 AND GB-176 ENGINE SPECIFICATIONS

GENERAL DATA

Application:	
G-176 Engines	MF 165, 3165 and MF 65 Gasoline Tractors
GB-176 Engines	MF 165 and MF 65 LP-Gas Tractors, Also used in MF 65 Hi-Altitude Gasoline Tractors
Bore	3-37/64 inches
Stroke	4-3/4 inches
Number of Cylinders	4
Total Piston Displacement	176 cu. inches
Compression Ratio:	
Gasoline Engines:	
MF 165 and 3165 Applications	7.1 to 1
MF 65 Application (Regular Altitude)	7.1 to 1
MF 65 Application (Hi-Altitude)	8.1 to 1
LP-Gas Engines:	
MF 165 Application	8.75 to 1
MF 65 Application	8.1 to 1
Firing Order	1-3-4-2
Engine Torque (Mfg. Minimum Torque Peak Rating):	
Gasoline Engines	155 Ft.-Lbs. Between 1150 and 1250 Engine rpm
LP-Gas Engines:	
MF 165 Applications	155 Ft.-Lbs. Between 1150 and 1250 Engine rpm
MF 65 Applications	151 Ft.-Lbs. Between 1150 and 1250 Engine rpm
Engine Brake Horsepower (Mfg. Minimum Rating with Accessories):	
Gasoline Engines	52 @ 2000 Engine rpm
LP-Gas Engines:	
MF 165 Application	52 @ 2000 Engine rpm
MF 65 Application	49 @ 2000 Engine rpm
Low Idle Speed	450-500 rpm
Rated Engine Speed	2000 rpm
High Idle Speed (no load)	2200-2250 rpm
Compression Pressure* (With Warm Engine, Spark Plugs Removed and Wide Open Throttle):	
Gasoline Engines:	
MF 165 and 3165 Applications	Approx. 145-160 psi @ 150 rpm Cranking Speed
MF 65 Application (Regular Altitude)	Approx. 145-160 psi @ 150 rpm Cranking Speed
MF 65 Application (Hi-Altitude)	Approx. 165-185 psi @ 150 rpm Cranking Speed
LP-Gas Engines:	
MF 165 Application	Approx. 180-195 psi @ 150 rpm Cranking Speed
MF 65 Application	Approx. 165-185 psi @ 150 rpm Cranking Speed

**Measured At Sea Level - Pressures will be reduced approximately 3% for each additional 1,000 ft. of altitude.*

Tappet Clearance (Hot):	
Intake	0.016 inch
Exhaust	0.018 inch
Approximate Engine Weight - Less Accessories	520 lbs.

ENGINE OVERHAUL SPECIFICATIONS

Torque Tensions

Cylinder Head	70-75 ft.-lbs.
Connecting Rods	40-45 ft.-lbs.
Main Bearings	85-95 ft.-lbs.
Flywheel	70-75 ft.-lbs.
Rocker Arm Supports	35-40 ft.-lbs.
Manifolds	25-30 ft.-lbs.
Camshaft Nut	125-130 ft.-lbs.
Oil Pan	12-16 ft.-lbs.

Other Miscellaneous Torques— (By Size—Diameter)

Diameter	1/4 Inch	5/16 Inch	3/8 Inch	7/16 Inch	1/2 Inch	9/16 Inch
Gear cover, water pump and misc. accessories and brackets	8-10	15-20	25-30	50-55	80-90	115-125
Die-castings	6-8	10-15	20-25	35-40	50-55	

Pistons

Piston Skirt Diameter (Measured at right angles from piston pin hole):	
Early Coded Type Pistons	See Chart
Late Uncoded Type Pistons	3.5755-3.5765 Inches (Skirt not tapered)
Piston Pin Bore Diameter	1.1253-1.1255 Inches

Cylinder Sleeves

Type	Wet
Inside Diameter of Sleeves:	
Early Coded Type	See Chart
Late Uncoded Type	3.578-3.579 Inches
Location of Sleeve Relative to top Face of Block	0.001 to 0.004 Inch Above

Piston and Sleeve Dimensions—Early Coded Type

Identification Letter	Piston Skirt Diameter (Skirt Not Tapered)	Sleeve Bore Size
A1	3.5755 - 3.576 inches	3.5775 - 3.578 inches
A	3.576 - 3.5765 inches	3.578 - 3.5785 inches
B	3.5765 - 3.577 inches	3.5785 - 3.579 inches
C	3.577 - 3.5775 inches	3.579 - 3.5795 inches
D	3.5775 - 3.578 inches	3.5795 - 3.580 inches
E	3.578 - 3.5785 inches	3.580 - 3.5805 inches

Piston Pins

Pin Diameter	1.1250 - 1.1252 inches
Clearance in Connecting Rod Bushing	0.0001 - 0.0005 inch
Clearance in Piston Pin Bore	0.0001 - 0.0005 inch

Piston Rings—Production Set

Ring Side Clearance:	
Top Compression Ring	0.003 - 0.0045 inch
No. 2 and 3 Compression Rings	0.002 - 0.0035 inch
Bottom Oil Control Ring	0.002 - 0.0035 inch
Ring End Gap (all rings).	0.010 - 0.020 inch

Connecting Rods

Inside Bushing Diameter (finished)	1.1253 - 1.1255 inch
Connecting Rod Bore Diameter	2.1865 - 2.187 inch
Rod Bearing Inside Diameter (standard size)	2.0632 - 2.0642 inches
Crankpin Journal Diameter	2.0615 - 2.0625 inches
Bearing Clearance - New	0.0007 - 0.0027 inch
Desired Bearing Clearance	0.0015 inch
Maximum Bearing Clearance	0.0037 inch
Rod Side-Play	0.006 - 0.010 inch

Crankshaft and Main Bearings

Cylinder Block Bore	2.5615 - 2.5622 inches
Main Bearing Inside Diameter	2.3755 - 2.3765 inches
Main Bearing Journal Diameter	2.374 - 2.375 inches
Main Bearing Clearance - New	0.0005 - 0.0027 inch
Desired Main Bearing Clearance	0.0015 inch
Maximum Main Bearing Clearance	0.0037 inch
Crankshaft End-Play and How Controlled	0.004 - 0.008 inch by center main bearing
Crankpin Journal Diameter	2.0615 - 2.0625 inches
Radii on Crankpins and Mains	3/32 inch

Valves

Valve Tappet Clearance (Hot):	
Intake	0.016 inch
Exhaust	0.018 inch
Valve Head Diameter:	
Intake	1.323 - 1.333 inches
Exhaust	1.198 - 1.208 inches
Valve Stem Diameter:	
Intake Valves:	
Diameter - New.	0.3406 - 0.3414 inch
Desired Stem Clearance	0.0015 inch
Wear Limits - Maximum Clearance	0.0049 inch

Valves *(Continued)*

Valve Stem Diameter: *(Continued)*	
Exhaust Valves:	
Diameter - New	0.3382 - 0.339 inch
Desired Stem Clearance	0.004 inch
Wear Limits - Maximum Clearance	0.0073 inch
Valve Face Angle:	
Intake	30°
Exhaust	44°
Valve Lift:	
Intake	0.383 inch
Exhaust	0.376 inch

Valve Seats

Valve Seat Angles:	
Intake	30°
Exhaust	45°
Seat Contact Width	1/16 to 3/32 inch
Maximum Seat Run-Out	0.002 inch
Production Exhaust Seat Inserts:*	
Outside Diameter of Insert	1.3475 - 1.3485 inches
Inside Diameter of Counterbore	1.3435 - 1.3445 inches
Press Fit	0.003 - 0.005 inch

**When the 0.010 inch oversize Service Replacement insert is used, the dimensions of the insert and counterbore increase proportionately.*

Valve Guides

Location Above Top of Cylinder Head	1/16 inch below rocker cover gasket surface
Inside Diameter - New	0.3420 - 0.3435 inch
Clearance Limits - New:	
Intake	0.0006 - 0.0029 inch
Exhaust	0.003 - 0.0053 inch

Valve Springs

Free Length	Approx. 2-5/64 inch
Spring Length Valve Closed	1-21/32 inch
Spring Pressure @ 1-21/32 Length	41-47 lbs.
Spring Length Valve Open	1-7/32 inch
Spring Pressure @ 1-7/32 Length	103-110 lbs.

Valve Lifters

Stem Diameter	0.5615 - 0.5620 inch
Valve Lifter Bore	0.5625 - 0.5635 inch
Clearance Limits - New	0.0005 - 0.002 inch
Maximum Clearance	0.003 inch

Rocker Arm Shaft Assembly

Direction of Oil Holes in Shaft	Toward push rods
Rocker Arm Shaft Diameter	0.9671 - 0.9677 inch
Inside Bushing Diameter	0.9687 - 0.9692 inch
Bushing Clearance	0.001 - 0.0021 inch

Valve Timing (Crankshaft Degrees)

Intake Valve Opens	0° T. D. C.
Intake Valve Closed	35° A. B. D. C.
Exhaust Valve Opens	40° B. B. D. C.
Exhaust Valve Closes	0° T. D. C.

Timing Gears

Timing Gear Backlash	0.001 - 0.002 inch

Camshaft

End-Play	0.003 - 0.007 inch
Cam Lift (intake and exhaust)	0.2768 inch
Bearing Diameters:	
Front Camshaft Support:	
Journal Diameter	0.9965 - 0.997 inch
Bushing Inside Diameter (Finished)	0.9995 - 1.000 inch
Clearance Limits	0.0025 - 0.0035 inch
No. 1 Camshaft Bearing (front):	
Journal Diameter	1.808 - 1.809 inches
Bushing Inside Diameter (Finished)	1.812 - 1.8125 inches
Clearance Limits	0.003 - 0.0045 inches
Block Bore Diameter	1.937 - 1.9375 inches
No. 2 Camshaft Bearing:	
Journal Diameter	1.7455 - 1.7465 inch
Block Bore Diameter	1.7495 - 1.750 inches
Clearance Limits	0.003 - 0.0045 inches
No. 3 Camshaft Bearing:	
Journal Diameter	1.683 - 1.684 inches
Block Bore Diameter	1.687 - 1.6875 inches
Clearance Limits	0.003 - 0.0045 inch
Maximum Wear of Camshaft Journal Diameters	0.001 inch under minimum diameter
Maximum Bearing Clearance	0.006 inch

FUEL SYSTEM SPECIFICATIONS

Gasoline Engine—Fuel System

Recommended Fuel	Use regular grade gasoline having a minimum octane rating of 94 (Research Method) or 86 (Motor Method)
Carburetor:	
Make and Model No.	
MF 165 and 3165 Applications	Marvel-Schebler TSX 884, or Zenith 267JX9 (No. 12548)
MF 65 Tractors	Marvel-Schebler TSX 695
Adjustments:	
Idle Adjusting Needle:	
TSX 884 and 267JX9 (No. 12548)	Approx. 1 to 1-1/2 turns open
TSX 695	Approx. 1 to 2 turns open
Main Adjusting Needle:	
TSX 884 and 267JX9 (No. 12548)	Approx. 1-1/2 to 2 turns open
TSX 695	Approx. 1-1/8 to 1-3/8 turns open
Engine Speeds:	
Low Idle Speed	450-500 rpm
High Idle Speed (No Load)	2200-2250 rpm
Float Level:	
TSX 884 and TSX 695	Set Floats 1/4 inch from gasket face to nearest edge of float keeping edge of float parallel with gasket
Zenith 267JX9	Set float 1-5/32 inch from top of floats to machined surface of throttle body (without gasket) with throttle body inverted

LP-Gas Engine—Fuel System

Fuel	Use a reliable brand of LP-Gas fuel which meets the Natural Gas Processors Association (NGPA) Specification for HD-5 Propane
Vaporizer (Primary Regulator):	
Make And Model No.:	
MF 165 LP-Gas Tractors	Zenith, A962-1
MF 65 LP-Gas Tractors Serial No. 692932 and Up	Zenith, A962-1
MF 65 LP-Gas Tractors Serial No. 673300 to 692932	Zenith, A965A-36
MF 65 LP-Gas Tractors Prior to Serial No. 673300	Zenith, A965A-21
Outlet Pressure	9-11 psi
Final Regulator:	
Make and Type:	
MF 165 LP-Gas Tractors	Integral Part of Carburetor
MF 65 LP-Gas Tractors Serial No. 673300 and up	Integral Part of Carburetor
MF 65 LP-Gas Tractors Prior to Serial No. 673300	Zenith, Type C
Zenith Type C Regulator Valve Adjustment	With adjusting screw seated lightly, slowly turn screw counter-clockwise and find point of bubble leak at outlet. Then turn adjusting screw to right (clockwise) 3/4 to 1 turn from this position.
Carburetor:	
Make and Model No.:	
MF 165 LP-Gas Tractors	Zenith, PC2J10 (No. 13295)
MF 65 LP-Gas Tractors Serial No. 692263 and Up	Zenith, PC2J10 (No. 12726)
MF 65 LP Gas Tractors Serial No. 673300 thru 692262	Zenith, PC1J10 (No. 12447)
MF 65 LP-Gas Tractors Prior to Serial No. 673300	Zenith, LPEX91 (No. 12256)

LP-Gas Engine—Fuel System *(Continued)*

Carburetor: *(Continued)*	
Engine Speed Settings:	
Low Idle Speed	450-500 rpm
Maximum Engine Speed (No. Load)	2200-2250 rpm
Adjustment Screw Settings:	
PC2J10 (Nos. 13295 and 12726):	
Idle Adjusting Needle	Approx. 2-1/4 to 2-3/4 turns open
Main Adjusting Needle	Approx. 2-5/8 to 3-1/8 turns open
PC1J10 (No. 12447):	
Idle Adjusting Needle	Approx. 2-1/4 to 2-3/4 turns open
Main Adjusting Needle	Approx. 3-1/4 to 3-3/4 turns open
LPEX91 (No. 12256):	
Idle Adjusting Needle	3/4 to 1-1/4 turns open
Main Adjusting Needle	2-3/4 to 3-1/4 turns open
Diaphragm Lever Setting:	
PC2J10 (Nos. 13295 and 12726)	Set Lever 0.040-0.050 Inch above face of throttle body casting
PC1J10 (No. 12447)	Set lever flush with face of throttle body casting
LPEX91 (No. 12256)	Not applicable

LUBRICATION SYSTEM SPECIFICATIONS

Type of Oil	API Service Class "MS" (heavy-duty, high detergent)
Viscosity:	
Above 90° F.	SAE 30
From 32° F. to 90° F.	SAE 30
From 10° F. to 32° F.	SAE 20W
From -10° F. to +10° F.	SAE 10W
Crankcase Capacity:	
Without Filter Change	5 U.S. quarts
With Filter Change	6 U. S. quarts
Recommended Oil Change Interval	100 hrs.
Recommended Oil Filter Change Interval	200 hrs.
Normal Operating Pressure	20-30 psi at 1800 rpm
Minimum Oil Pressure	7 psi at 450 rpm
Relief Valve Setting	30 psi
Backlash in Oil Pump Gear	0.004 - 0.008 inch

COOLING SYSTEM SPECIFICATIONS

Radiator Pressure Cap	7 psi
Fan Belt Deflection	1/2 - 3/4 inch
Thermostat Opening Temperature	160° F.
Impeller Clearance	0.020 - 0.030 inch below body face

ELECTRICAL SYSTEM SPECIFICATIONS

Battery:	
Make and Part Number:	
Gasoline Engine:	
MF 165 and 3165 Tractors with Live PTO	Massey-Ferguson, 832 706 M2
MF 165 Tractors with Independent PTO	Massey-Ferguson, 832 704 M2
MF 65 Tractors	Massey-Ferguson, 832 706 M2
LP-Gas Engines:	
MF 165 Tractors with Live PTO	Massey-Ferguson, 832 705 M2
MF 165 Tractors with Independent PTO	Massey-Ferguson, 832 709 M2
MF 65 Tractors	Massey-Ferguson, 832 705 M2
Volts	12
Ampere Hours @ 20-Hour Rate:	
MF 832 704 M2	60
MF 832 705 M2	53
MF 832 706 M2	41
MF 832 709 M2	95
Number of Plates Per Cell:	
MF 832 704 M2	11
MF 832 705 M2	9
MF 832 706 M2	7
MF 832 709 M2	17
Battery Ground	Negative
Spark Plugs:	
Size	18mm
Normal Heat Range:	
Gasoline Engines	Champion D-16 or MF 1027 896 M91
LP-Gas Engines	Champion D-14 or MF 1027 894 M91
Gap:	
Gasoline Engines	0.025 Inch
LP-Gas Engines	0.020 Inch
Torque	32-38 Ft.-Lbs.
Distributor:	
Make and Model No.:	
MF 165 and 3165 Tractors (Gasoline and LP-Gas)	Delco-Remy 1112644
MF 65 Tractor Serial No. 702826 and up (Gasoline and LP-Gas)	Delco-Remy 1112644
MF 65 Gasoline Tractors Prior to Serial No. 702826	Delco-Remy 1112583
MF 65 LP-Gas Tractors Prior Serial to No. 702826	Delco-Remy 1112589
Type of Advance	Centrifugal
Direction of Rotation (viewing drive end)	Clockwise
Point Gap	0.018-0.024 Inch, Set at 0.022 Inch
Dwell Angle:	
DR-1112644	31-34°
DR-1112583 and DR-1112589	25-34°
Point Spring Tension (behind contact)	19-23 ozs.
Ignition Timing (crankshaft degrees and rpm):	
Initial Setting @ 450 rpm:	
MF 165 Gasoline and LP-Gas Tractors	6° BTDC
MF 65 Gasoline Tractors	6° BTDC
MF 65 LP-Gas Tractors	4° BTDC
Desired Setting @ 2000 rpm:	
MF 165 Gasoline and LP-Gas Tractors	26° BTDC
MF 65 Gasoline Tractors	26° BTDC
MF 65 LP-Gas Tractors	24° BTDC

ELECTRICAL SYSTEM SPECIFICATIONS *(Continued)*

Distributor: *(Continued)*	
Drive Shaft End Play	0.002-0.010 Inch
Distributor Advance Data (distributor degrees and rpm):	
DR-1112644 and DR-1112583 Distributors:	
325 RPM	0-2° (Start of advance)
700 RPM	6-8° (Intermediate advance)
1000 RPM	9-11° (Maximum advance)
DR-1112589 Distributors:	
300 RPM	0-2° (Start of advance)
650 RPM	6-8° (Intermediate advance)
825 RPM	9-11° (Maximum advance)

Coil

Make and Model No. Used	Delco-Remy 1115071
Volts	12
Primary Resistance @ 75° F.	3.2-4 ohms
Secondary Resistance @ 75° F.	6500-9500 ohms

Starter Motor

Make and Model Number:	
MF 165 Tractors Serial No. 643013659 and Up	Delco-Remy 1108324
MF 165 Tractors Prior to Serial No. 643013659	Delco-Remy 1107329
MF 3165 Utility Tractors Serial No. 647002021 and Up	Delco-Remy 1108324
MF 3165 Utility Tractors Prior to Serial No. 647002021	Delco-Remy 1107329
MF 3165 Turf Tractors Serial No. 649000161 and Up	Delco-Remy 1108324
MF 3165 Turf Tractors Prior to Serial No. 649000161	Delco-Remy 1107329
MF 65 Agr. Tractors Serial No. 691660 and Up	Delco-Remy 1107226
MF 65 Agr. Tractors Prior to Serial No. 691660	Delco-Remy 1107654
MF 65 Utility Tractors Serial No. 703204 and Up	Delco-Remy 1107329
MF 65 Utility Tractors Serial No. 691669 thru 703203	Delco-Remy 1107226
DR-1108324 Starter Motor Specifications:	
Rotation (viewing drive end)	Clockwise
Minimum Brush Tension (oz.)	35
Pinion Clearance	0.010-0.140 Inch
No Load Test:	
Volts	10.6
Min. Amps	49 (includes solenoid)
Max. Amps	87 (includes solenoid)
Min. RPM	6200
Max. RPM	10700
Resistance Test:	
Volts	4.3
Min. Amps	290
Max. Amps	425
DR-1107329 Starter Motor Specifications:	
Rotation (viewing drive end)	Clockwise
Minimum Brush Tension (oz.)	35

Starter Motor *(Continued)*

DR-1107329 Starter Motor Specifications: *(Continued)*	
Pinion Clearance	0.010-0.140 Inch
No Load Test:	
Volts	10.6
Min. Amps	49 (includes solenoid)
Max. Amps	76 (includes solenoid)
Min. RPM	6200
Max. RPM	9400
Resistance Test:	
Volts	4.3
Min. Amps	270 (includes solenoid)
Max. Amps	310 (includes solenoid)
DR-1107226 and DR-1107654 Starter Motor Specifications:	
Rotation (viewing drive end)	Clockwise
Minimum Brush Tension (oz.)	35
No Load Test:	
Volts	10.3
Max. Amps	75
Min. RPM	6900
Lock Test:	
Amps	435
Min. Torque (ft.-lbs.)	10.5
Approx. Volts	5.8

Generator

Make and Model No.:	
MF 165 and 3165 Tractors	Delco-Remy 1100435
MF 65 Gasoline Tractors Serial No. 694649 and up, also MF 65 LP-Gas Serial No. 694699 and up	Delco-Remy 1100435
MF 65 Tractors Serial No. 663016 Thru 694648 (Gasoline). and thru 694698 (LP-Gas), also used Serial No. 662839 thru 662903	Delco-Remy 1100362
MF 65 Tractors Prior to Serial No. 662839, also used tractor Serial Nos. 662903 thru 663015	Delco-Remy 1100998
DR-1100435 Generator Specifications (D.C.):	
Rotation (viewing drive end)	Clockwise
Circuit	A
Brush Spring Tension	28 oz.
Field Current (80° F.):	
Amps	1.58-1.67
Volts	12
Cold Output:	
Amps	25
Volts	14.0
Approx. Rpm	3040
DR-1100362 Generator Specifications (D.C.):	
Rotation (Viewing Drive End)	Clockwise
Circuit	A
Brush Spring Tension	28 oz.
Field Current (80° F.):	
Amps	1.58-1.67
Volts	12

Generator *(Continued)*

DR-1100362 Generator Specification (D. C.): *(Continued)*	
Cold Output:	
Amps	20
Volts	14.0
Approx. RPM	2300
DR-1100998 Generator Specifications (D. C.):	
Rotation (Viewing Drive End)	Clockwise
Circuit	A
Brush Spring Tension	16 oz.
Field Current @ 12 V. at 80° F.	2.0-2.14
Cold Output:	
Amps	13-16
Volts	14.0
Approx. RPM	2600
Hot Output:	
Amps	10-12
Volts	14.0
Approx. RPM	2800

***Regulator** (**Used With D.C. Generators**)*

Make and Model Number	Delco-Remy 1118981
Circuit	A
Voltage Regulator:	
Air Gap	0.075"
Allowable Voltage Range	13.6-14.5
Adjust to	14
Cut-Out Relay:	
Air Gap	0.020"
Point Opening	0.020"
Adjust to Close at	12.8 volts
Allowable Closing Range	11.8-14.0 volts

GROUP I — SECTION A — PART 3

CYLINDER HEAD ASSEMBLY SERVICING

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Valve Seat Reconditioning 7
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The cylinder head assembly as referred to in this part consists of the cylinder head complete with valves, rocker arm assembly and push rods. To obtain specifications and step by step removal and installation procedures, refer to the individual engine sections.

When the head is removed from the block, it is possible to remove the valves by compressing the valve springs with the valve spring compressor as shown in Fig. 1. The locks, spring retainer and spring may then be lifted off from the valve stem. Always place the valves in a numbered rack so that they can be reinstalled in their original position.

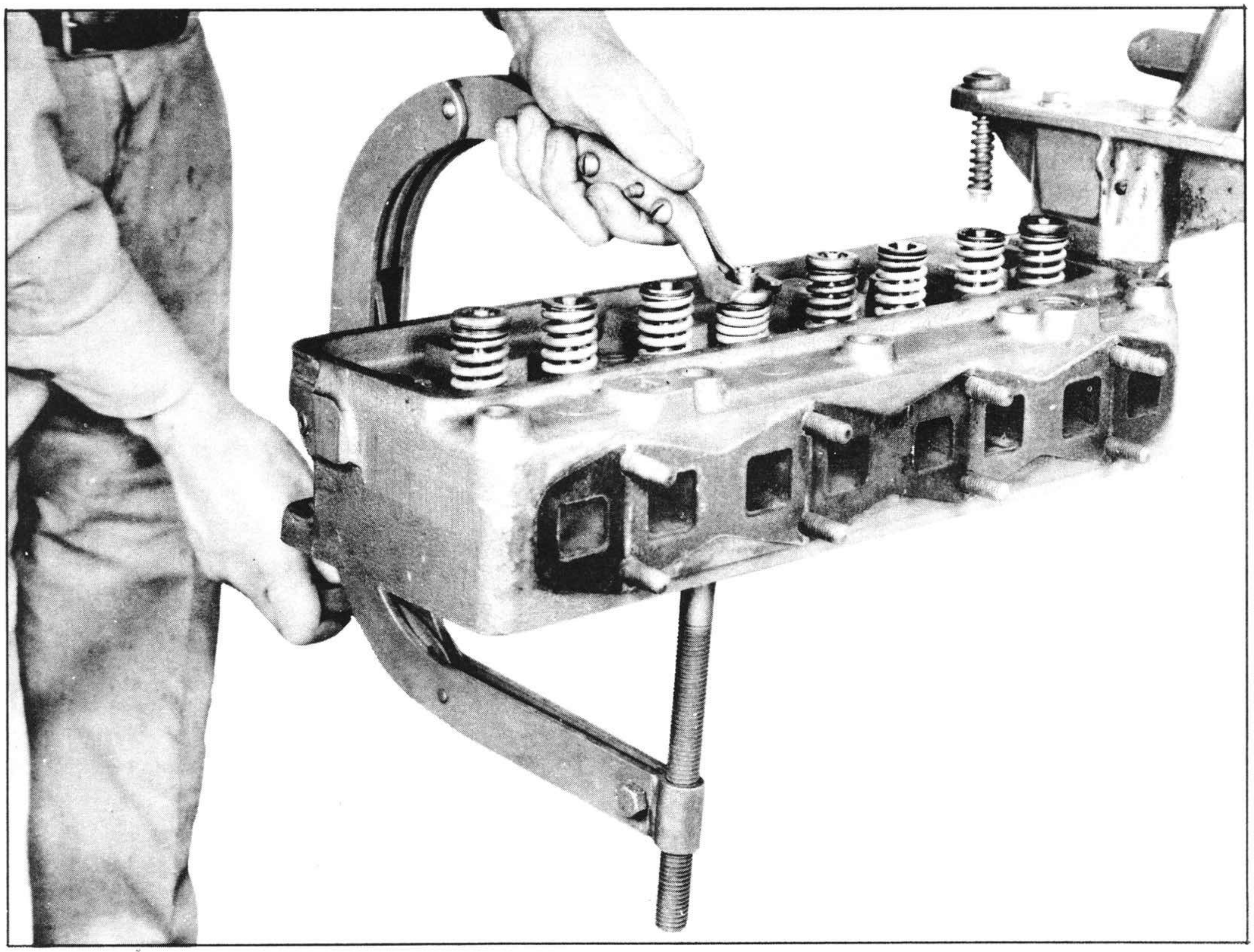


Fig. 1 - Using a Valve Spring Compressor

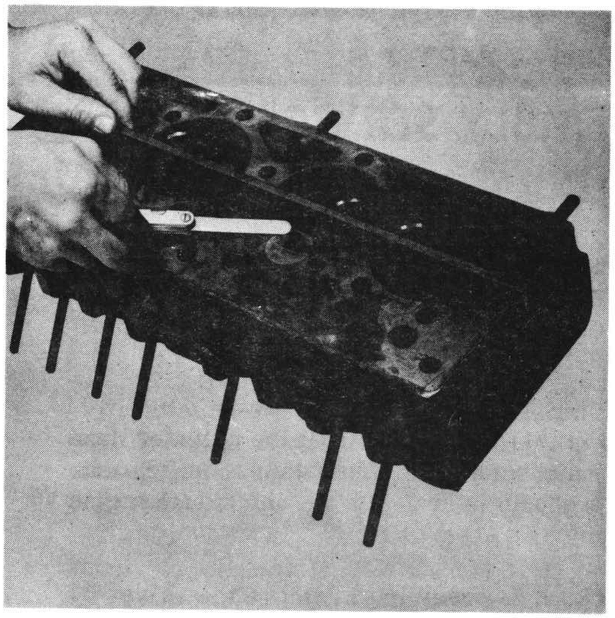


Fig. 2 - Checking For Cylinder Head Warping

CLEANING THE CYLINDER HEAD

Remove the intake and exhaust manifolds and clean off any carbon deposits, or old gasket material from the cylinder head with a suitable solvent.

Flush out and thoroughly clean the water passages in the head. Check with the compressed air to make sure that the passages are open. If the water jacket of the cylinder head shows signs of excessive scale, a good brand of descaling solution should be used, closely following the manufacturer's recommendations.

Test all oil passage holes with compressed air to determine if obstructions are present.

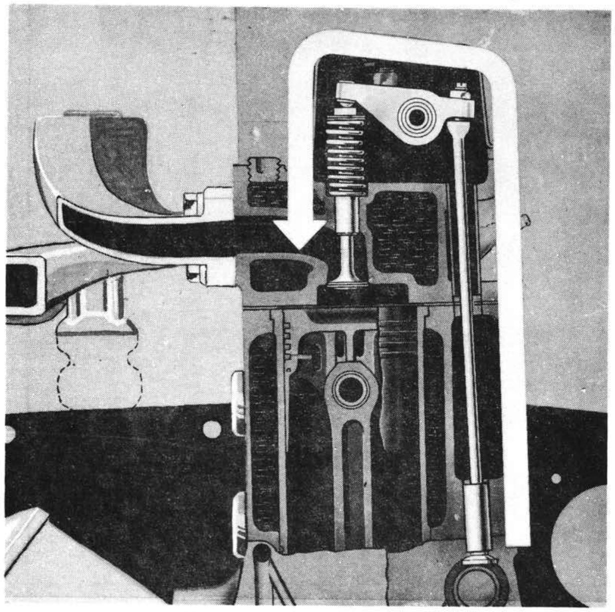


Fig. 3 - The Valve Train

INSPECTING THE CYLINDER HEAD

Once cleaned, the cylinder head should be visually inspected for cracks. Use a straightedge and feeler gauge to check for warping of the head, as shown in Fig. 2.

VALVE SERVICING

THE VALVE TRAIN

The valve train, as shown in Fig. 3, of all Massey-Ferguson 4-cycle engines, consists of a cam follower (or tappet), push rod, rocker arm and rocker shaft, and an intake and exhaust valve assembly for each cylinder. Push rods are present in all engines except the 3A/152 and 4A/203 diesel.

The importance of a properly functioning valve train cannot be over-emphasized. In modern high compression engines, terrific demands are placed on the valves. One of the main reasons for loss of power and performance and for wasted fuel and oil is faulty valve action. It is imperative that the valves be serviced when a compression check indicates that they are not in peak operating condition. Whenever the head is removed the valves should be inspected and serviced if necessary.

VALVE RECONDITIONING

INSPECTING THE VALVE

Exact tolerances in the valve train assembly are necessary for efficient engine performance. Several gauge checks must be made on the valve before it can be determined if the valve is suitable for use.

Fig. 4 shows the names of the various areas of the valve.

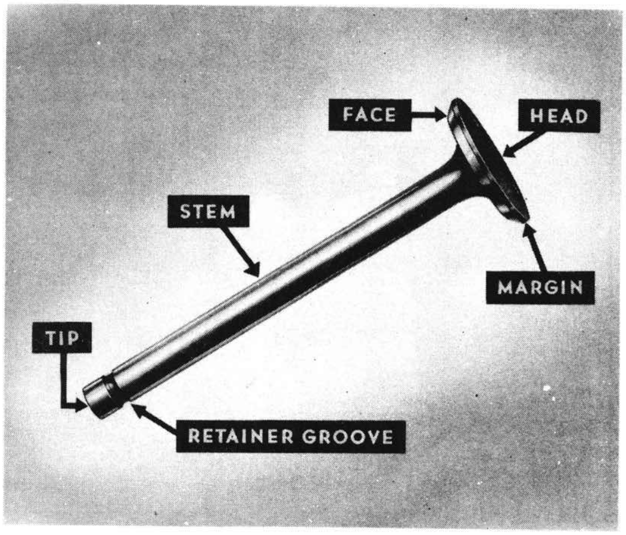


Fig. 4 - Valve Nomenclature

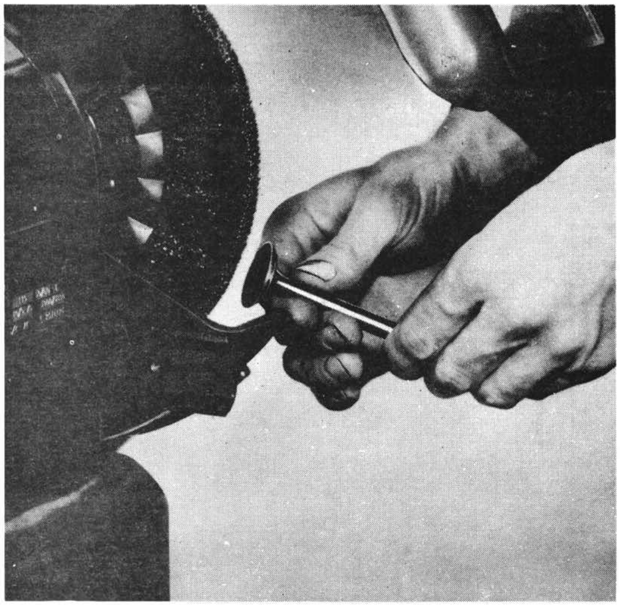


Fig. 5 - Cleaning the Valve

Preparing the Valve for Inspection

Having removed the cylinder head and the intake and exhaust valves from the head, wash the valves, springs, caps and retainers in a suitable solvent. Solvent cleaning ordinarily will not remove all of the deposits from the valves. A wire brush, as shown in Fig. 5, will do this job satisfactorily.

Inspection of the Valves

The valves should be given a visual inspection for the defects shown in Figs. 6, 7 and 8.

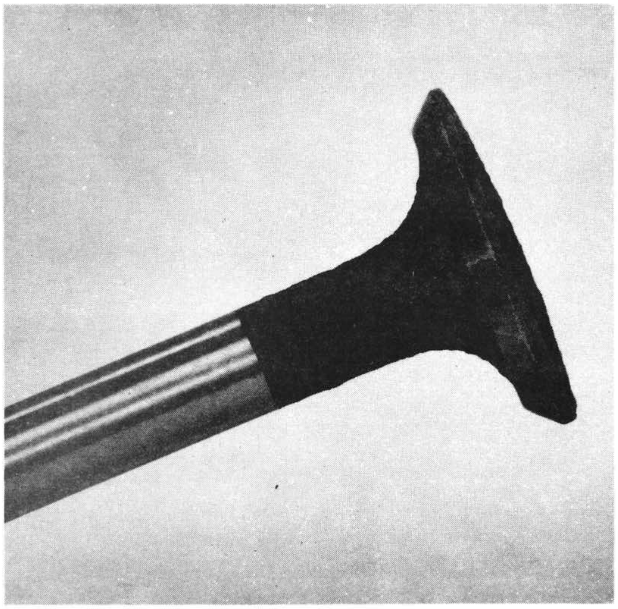


Fig. 6 - "Burned" Valve

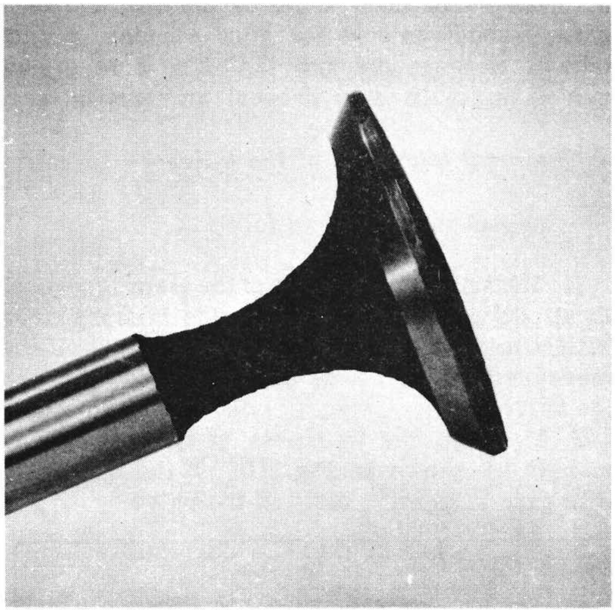


Fig. 7 - "Necked" Valve

Deep burns. - Valves which have deep burns should be discarded.

Necking. - This will show up as a smaller stem diameter near the head of the valve and is a result of intense heat and corrosion.

Scuffing. - Badly scuffed stems cause rapid guide wear and should be discarded. Slight scuffing at the ends of the guide contact area may be polished with crocus cloth and the valves returned to service if the stem diameter is within specifications.

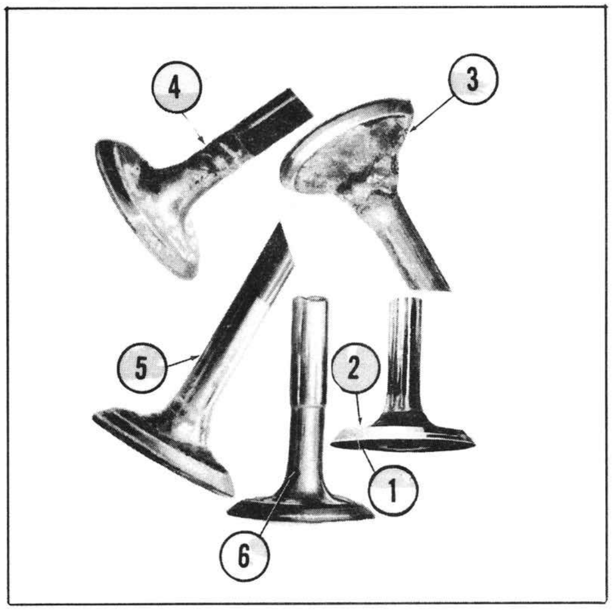


Fig. 8 - Defective Valves

1. Sharp edge
2. Uneven face
3. Carbonized valve
4. Burned valve
5. Worn stem
6. Cocked stem

If the valve falls short of meeting the necessary requirements for good service, do not take a chance; discard it. The cost of new valves is justified to prevent an early failure.

Dimensional Inspection of the Valve

Inspect the valves as follows:

1. Measure the diameter of the stem at several locations along the shiny guide bearing area with a micrometer, as shown in Fig. 9. If the measurement is below specifications, discard the valve.
2. Measure the thickness of the valve head margin as shown in Fig. 10. If the margin is less than 1/32 inch, discard the valve.

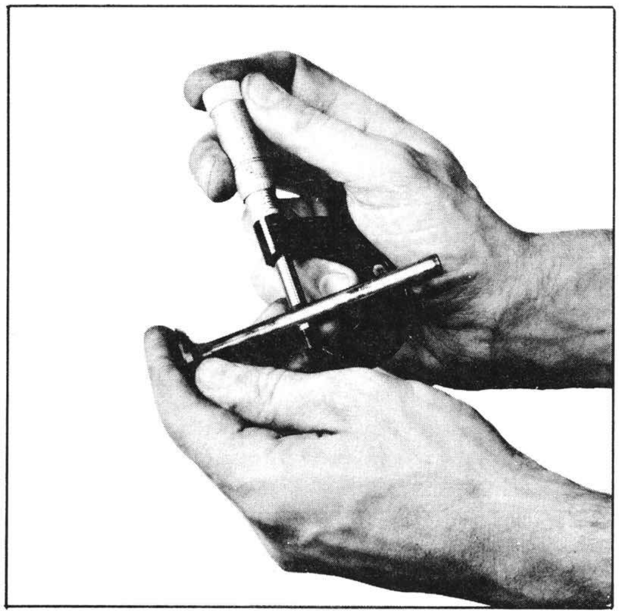


Fig. 9 - Checking for Valve Stem Wear

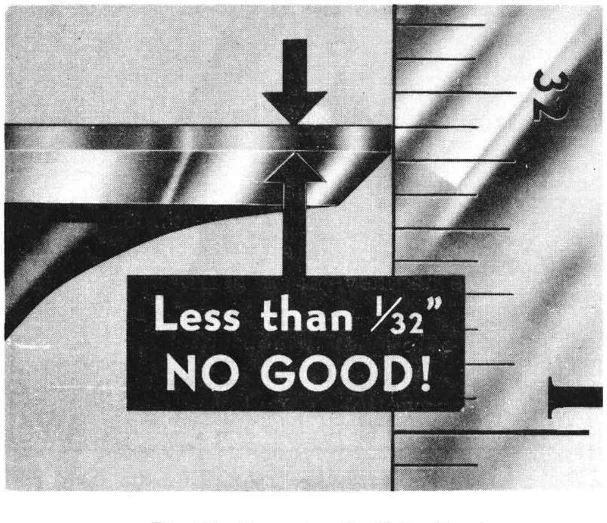


Fig. 10 - Measuring the Valve Margin

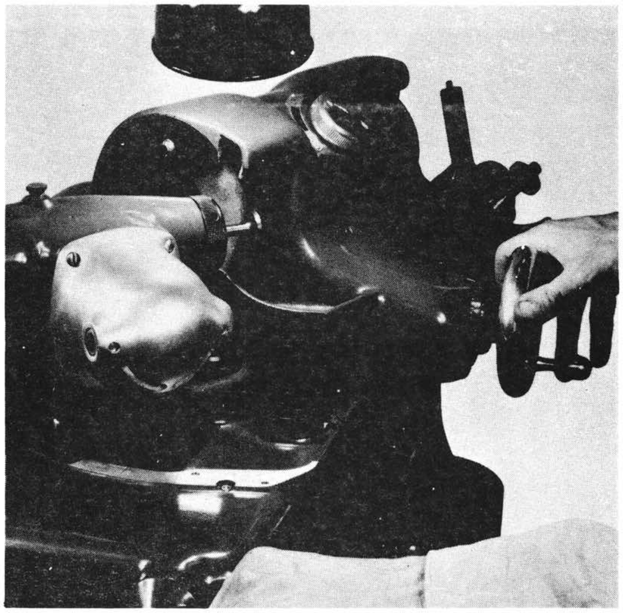
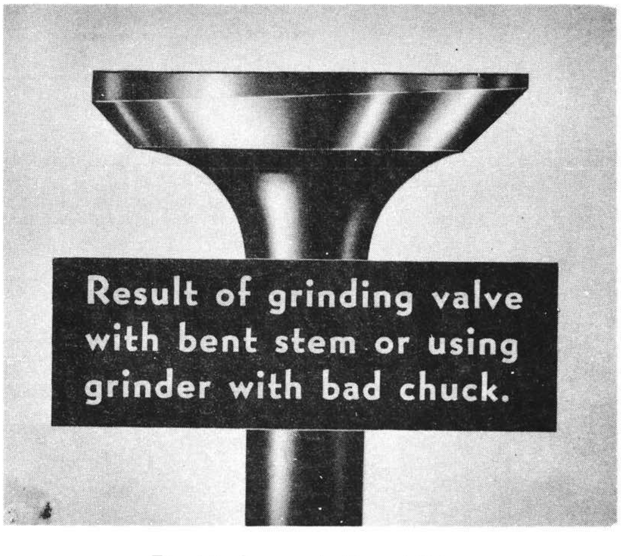


Fig. 11 - Refacing the Valve

REFACING THE VALVES

Before refacing the valve make sure that the grinding wheel is properly dressed and that the work-head is set for the specified face angle. Also, make sure that the valve stem and the jaw surfaces of the chuck are clean so that the valve will be held true. Install valve and chuck securely then take light grinding cuts across the full face of the wheel, as shown in Fig. 11. Remove only enough metal to true the valve face.

NOTE: Discard any valves that have bent stems or distorted heads, see Fig. 12.



Result of grinding valve with bent stem or using grinder with bad chuck.

Fig. 12 - Improperly Ground Valve

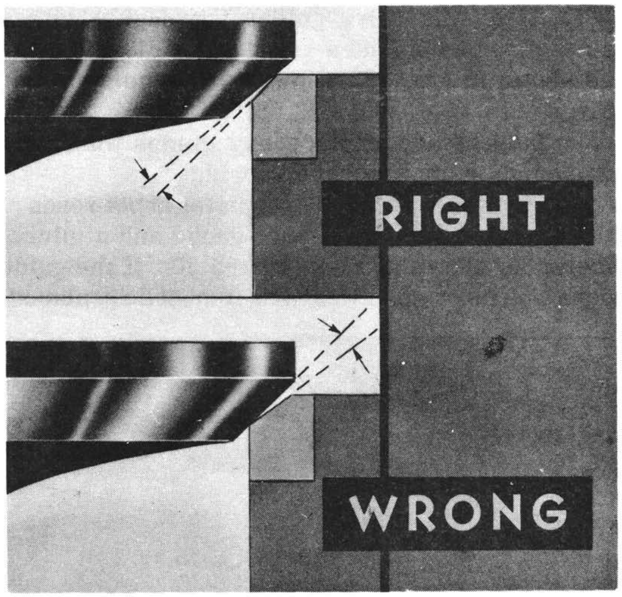


Fig. 13 - Grinding with an Interference Angle

Refacing Valves with an Interference Angle

Interference angle refacing is done to provide a narrow-line point of contact between the valve and its seat so that the effect of carbon deposits is minimized. The valve face is ground to the smaller angle than the valve seat. For example; if the valve seat is ground to 45^{0} and the valve face to 44^{0}, we have a 1^{0} interference angle present. This is illustrated in the RIGHT portion of Fig. 13. If the valve seat and valve face are ground as shown in the WRONG portion of Fig. 13, carbon deposits quickly build up and cause trouble in the opening between the valve and seat. This happens because the opening is directly exposed to the combustion chamber.

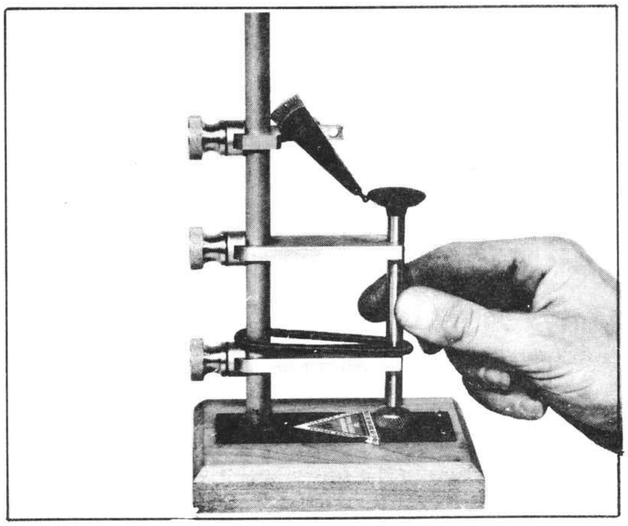


Fig. 14 - Checking Valve Face Runout

POST-REFACING INSPECTION

Upon completion of the valve refacing, be sure to make the following checks.

1. Check the margin thickness. If it is less than 1/32 inch, discard the valve.
2. Check the face runout as shown in Fig. 14. Discard all valves that exceed specifications.

VALVE GUIDES

FUNCTION OF THE VALVE GUIDES

The primary function of the valve guide is to hold the valve stem true in the center of the valve seat, see Fig. 15.

Another function of the valve guide is to transfer heat from the valve to the coolant. Fig. 16 shows the two paths that heat can follow to reach the coolant.

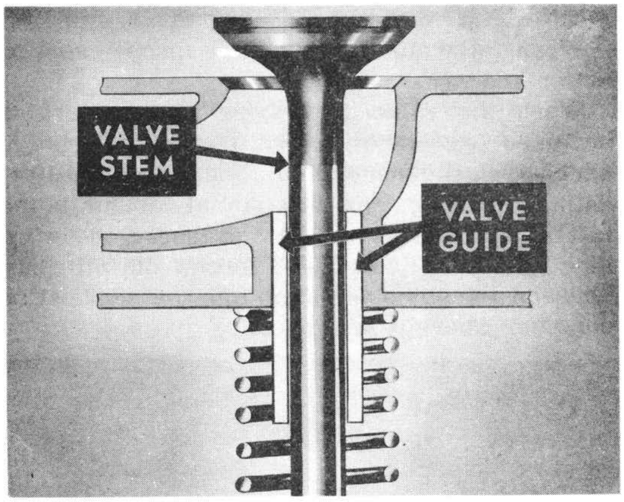


Fig. 15 - Proper Valve - Valve Guide Fit

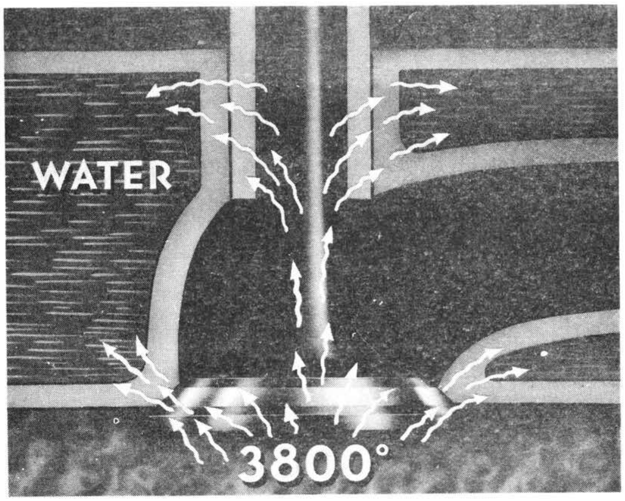


Fig. 16 - Paths of Heat Transfer

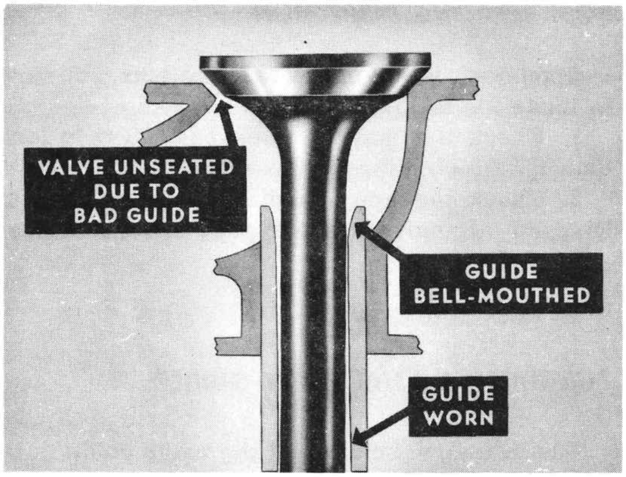


Fig. 17 - Valve Guide Wear

RESULTS OF WORN VALVE GUIDES

Wear from side pressures exerted on the valve stem by the rocker arm eventually make the bore of the valve guide egg-shaped or bell-mouthed at the ends as shown in Fig. 17.

Worn valve guides cause an improper seating action and early valve failure.

When the valve guide bore in a gas engine becomes excessively worn, it can be a cause of excessive oil consumption. The pressure differential resulting from the partial vacuum in the intake port and atmospheric pressure on the top side of the cylinder head forces the oil down between the guide and stem into the combustion chamber where it is burned.

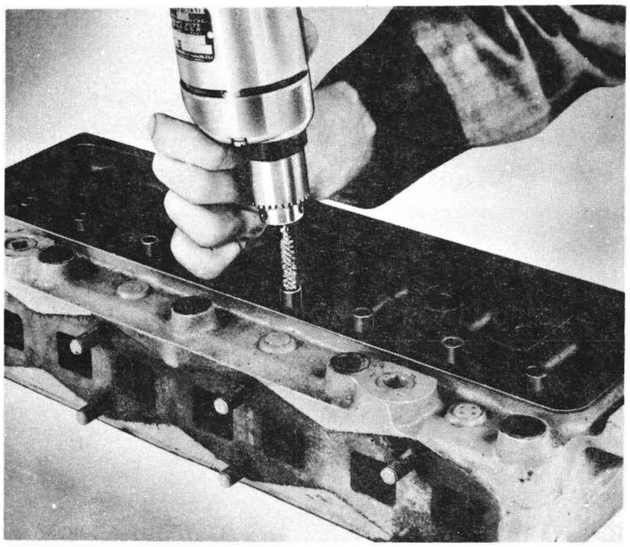


Fig. 18 - Cleaning Valve Guides

INSPECTING THE VALVE GUIDES

Valve guide inspection is important and cannot be over-emphasized. The guides should be inspected as follows:

1. Clean the valve guides thoroughly with a suitable solvent and a valve guide cleaning tool as shown in Fig. 18. Blow dry with compressed air.
2. Inspect and replace any guides which are damaged or show severe scoring.
3. Measure the inside diameter at both ends of the guide with a small-bore gauge and a micrometer as shown in Figs. 19 and 20. If the guide does not meet specifications it must be replaced.

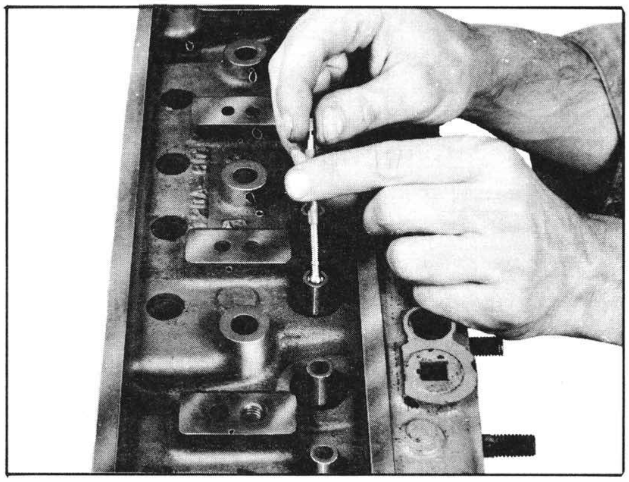


Fig. 19 - Fitting Small-Bore Gauge

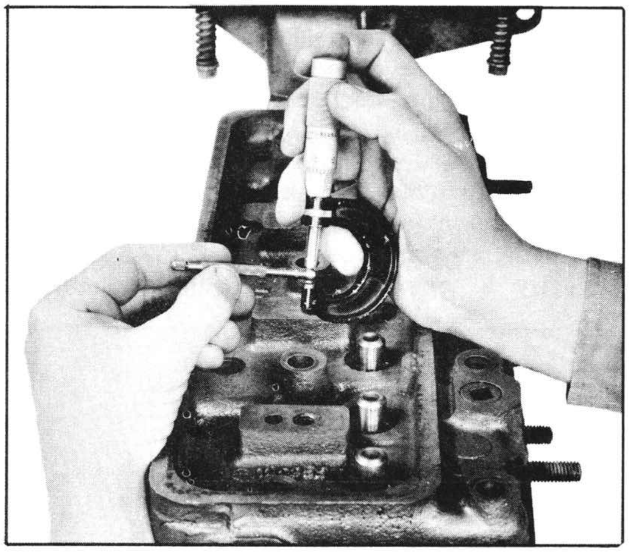


Fig. 20 - Miking the Small-Bore Gauge

NOTE: If the guide is excessively worn, worn off-center, bell-mouthed or egg-shaped, check to make sure that the rocker arm and cap are not worn and that they are positioned directly over the center of the valve stem. REPLACE WORN VALVE GUIDES BEFORE SERVICING THE VALVE SEATS.

INSTALLING THE VALVE GUIDES

Guide installation must be done carefully to prevent distortion and damage to the guide.

Replacement of valve guides is made easy with special tools approved by Massey-Ferguson and released by specialty tool manufacturers. By using an arbor press as shown in Fig. 21, the possibility of damaging the guides during installation is held to a minimum. A mandrel of the proper size is a must for proper installation. See individual engine sections for installation instructions.

When installing new valve guides in an engine where old valves will be used, make sure that the valve guide-to-stem clearances are within specifications.

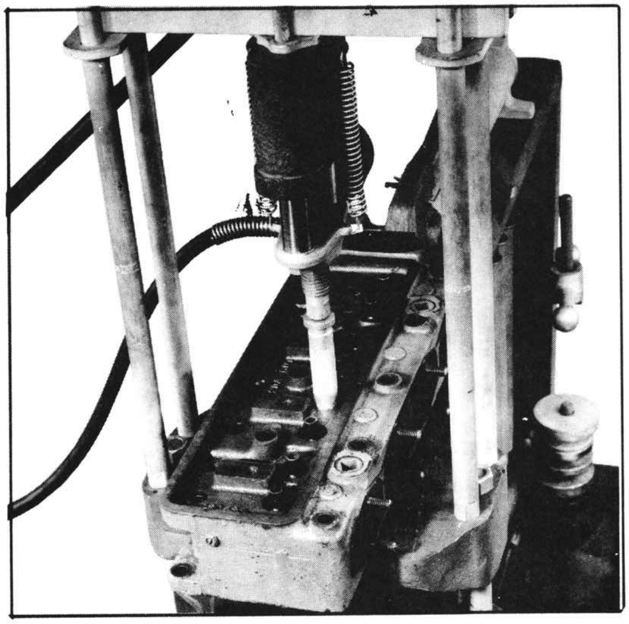


Fig. 21 - Installing New Valve Guides

REAMING VALVE GUIDES AFTER INSTALLATION

In valve guides which require reaming after installation, make sure to use a guide reamer of the correct size.

> *NOTE: If a worn reamer is used, it will reduce valve stem-to-guide clearance sufficiently to cause valve sticking.*

Never ream prereamed guides; to determine if a guide is prereamed insert a new valve into the guide. If the valve enters the guide easily, the guide is prereamed.

VALVE SEAT RECONDITIONING

FUNCTION OF THE VALVE SEAT

Valve seats serve two primary functions; they provide 1) a sealing surface for the valve face and 2) good contact between the valve face and valve seat to conduct heat from the valve head to the coolant.

INSPECTING THE VALVE SEAT

Before the actual inspection of the valve seat can begin, the seat must be cleaned. Remove all the carbon from the seats by using a suitable solvent and a wire brush as shown in Fig. 22 and dry with compressed air.

Make a visual inspection for fine hair-line cracks and general condition. If a seat is cracked, loose, burned or pitted it must be replaced.

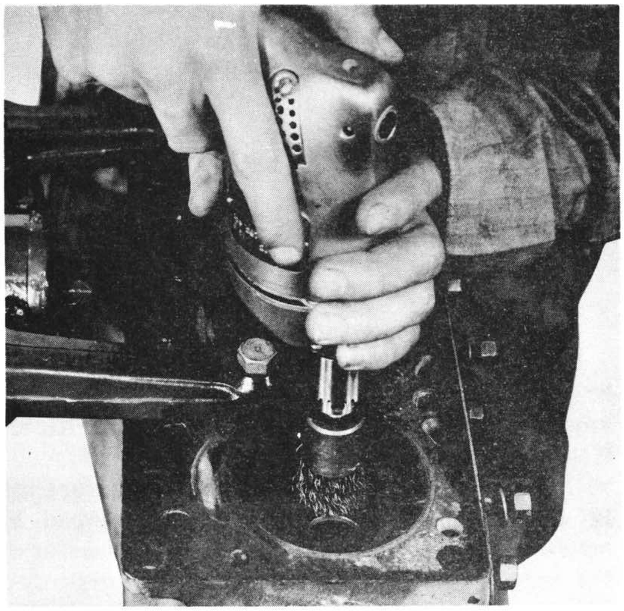


Fig. 22 - Cleaning the Valve Seat

REPLACING THE VALVE SEAT INSERTS

Not all Massey-Ferguson engines are manufactured with replaceable exhaust seat inserts. Refer to the individual engine sections for information and special procedures.

The removal and replacement of valve seat inserts is a critical but simple mechanical operation. The old insert may be removed by using one of the special tools developed for this purpose. Fig. 23 shows a ring extractor being used. By using such a tool, head distortion and recess damage are held to a minimum.

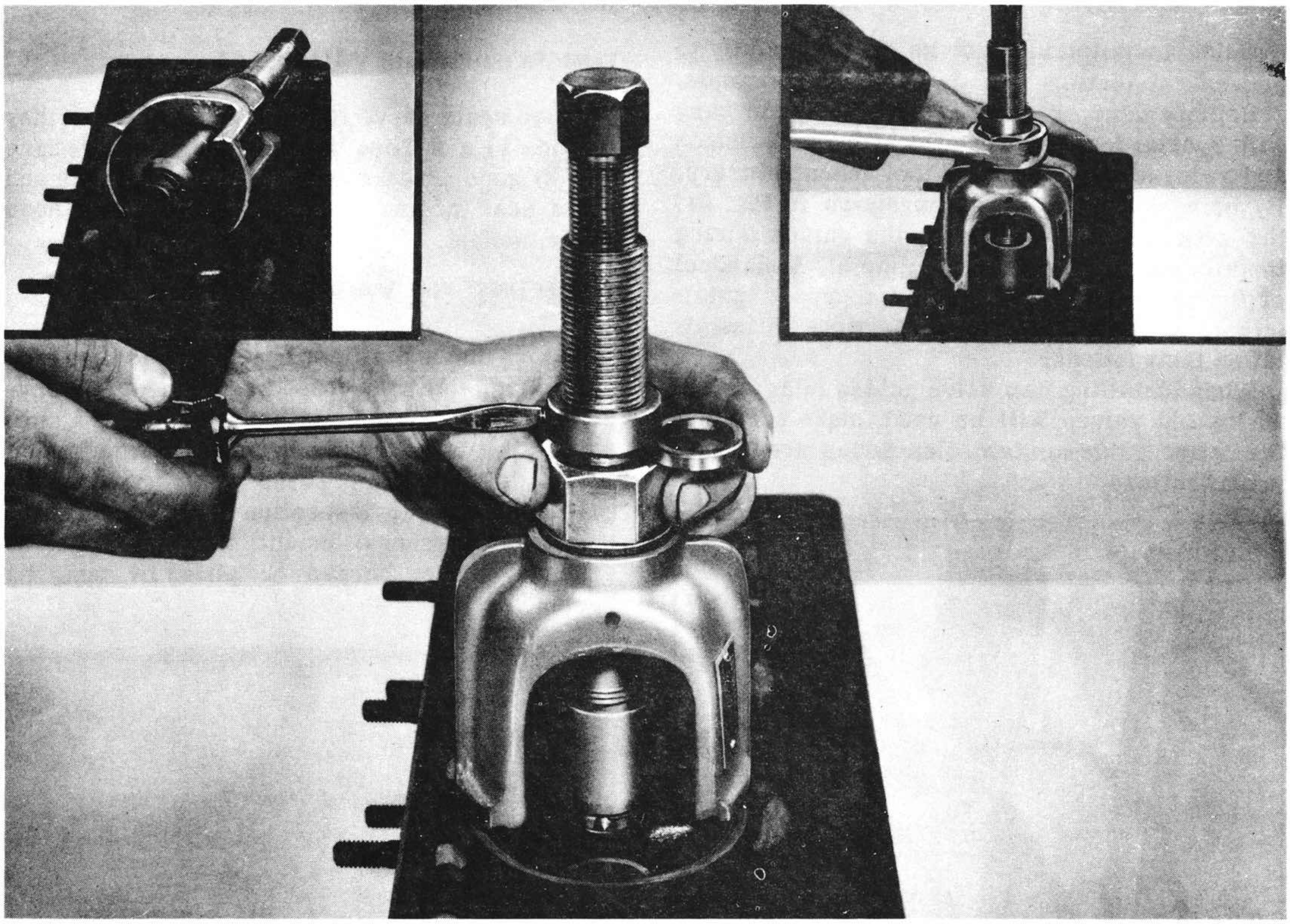


Fig. 23 - Removing A Valve Seat Insert

Inserts used in Massey-Ferguson tractors are held in place with an interference fit. The amount of interference used is quite critical. If too little interference is used, the seat will become loose. If too much interference is used the extreme pressure developed at operating temperature will alter the diameter of the insert resulting in a permanently distorted valve seat. When this happens, the insert quickly loosens. Most Massey - Ferguson tractors use a 0.003 inch interference fit as shown in Fig. 24; check the engine specifications, however, to determine exactly the interference fit to be used. Most inserts are 0.010 inch oversize as shown in Fig. 25, the insert recess must be enlarged to accommodate the oversized insert. New valve guides must be installed to accurately cut the recess and install the new seats.

NOTE: Refer to the individual engine section of the manual for specifications and special instructions concerning seat inserts.

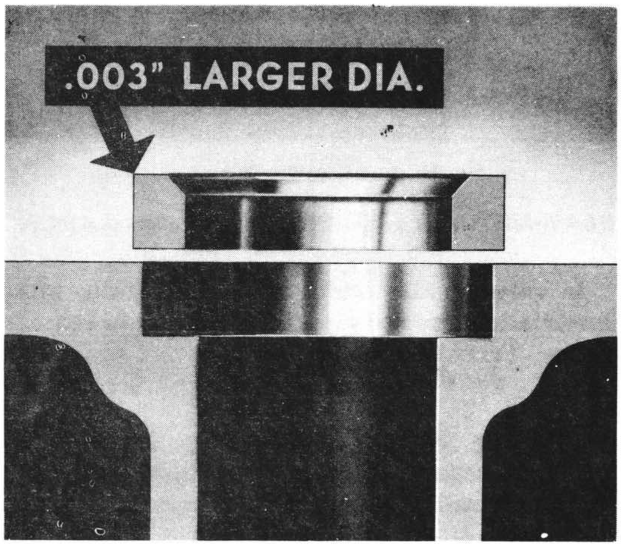


Fig. 24 - Interference Fit (Valve Seat Insert)

To insure that the insert properly seats in its recess, select the correct sized cutting attachment and use a dependable recess cutting tool such as that shown in Fig. 26. After cutting the recess, carefully clean out the cuttings.

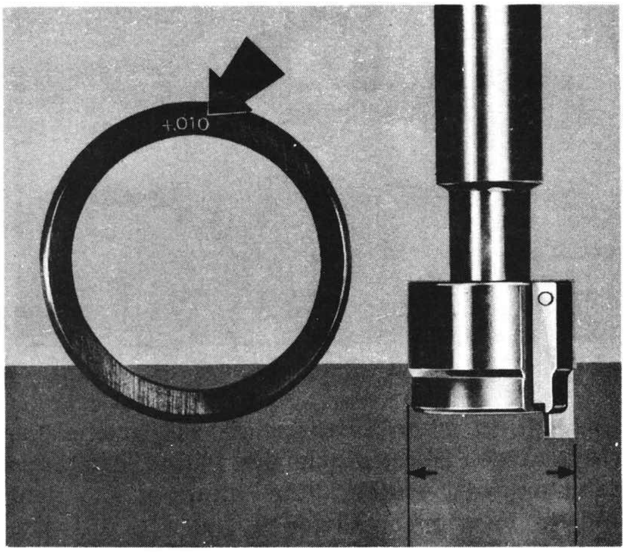


Fig. 25 - Oversized Valve Seat Insert (Replacement)

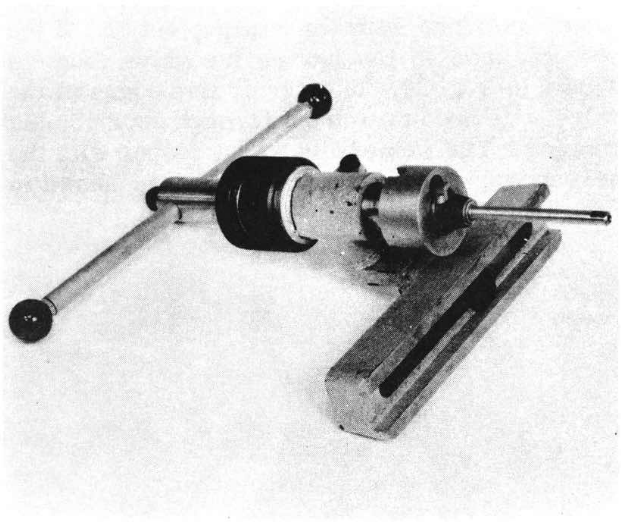


Fig. 26 - Recess Cutting Tool

Never install a seat without using the correct pilot to insure that the seat is square with the recess. Install the new insert with an arbor press as shown in Fig. 27.

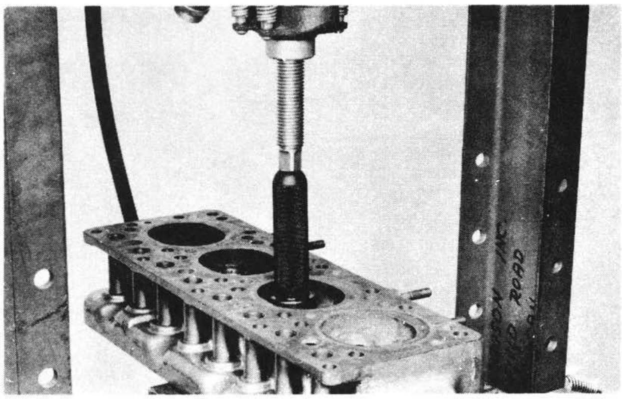


Fig. 27 - Installing New Valve Seat Inserts

REFACING THE VALVE SEAT

To properly recondition the valve seats it is necessary to use a motor driven seat grinder.

> *NOTE: Valve height is critical in diesel engines. See individual engine sections for special instructions and specifications.*

Clean all carbon from the valve seats with a wire brush before refacing. Use care to prevent scoring the seat. Select the correct pilot to guide the stone. Also select the proper stone for the angle and diameter of the seat as well as the type of metal it will be grinding. Dress the stone frequently to assure correct refacing of all the seats.

The general procedure for valve seat refacing follows; however, the manufacturer's recommendations for the use of your particular grinder must be adhered to.

1. Inspect the pilot for wear and straightness as shown in Fig. 28.

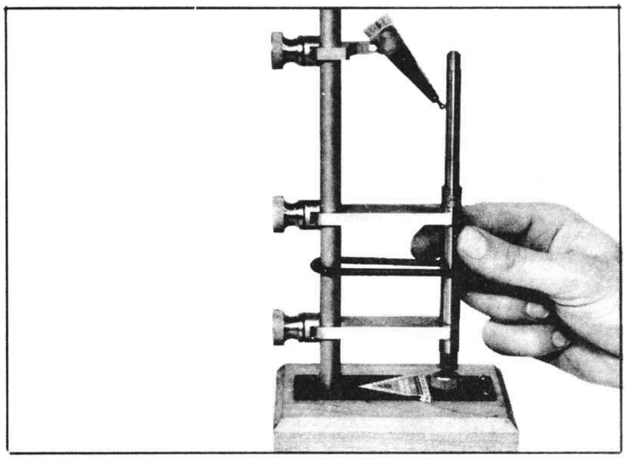


Fig. 28 - Checking For Bent Pilot

2. Select the proper stone for seat angle and material. Dress the stone as required, see Fig. 29.

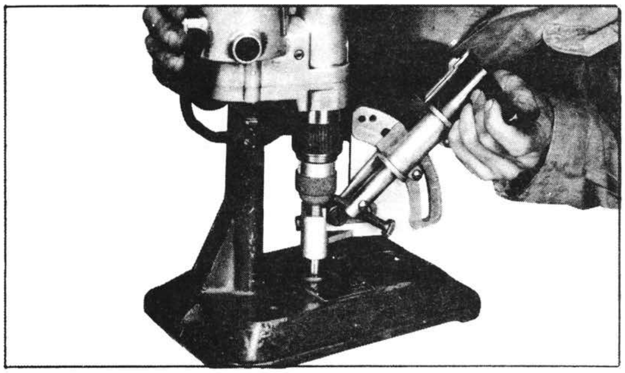


Fig. 29 - Dressing the Grinding Stone

3. Clean the seat by hand with emery cloth.

4. Tighten the pilot in the valve guide as shown in Fig. 30.

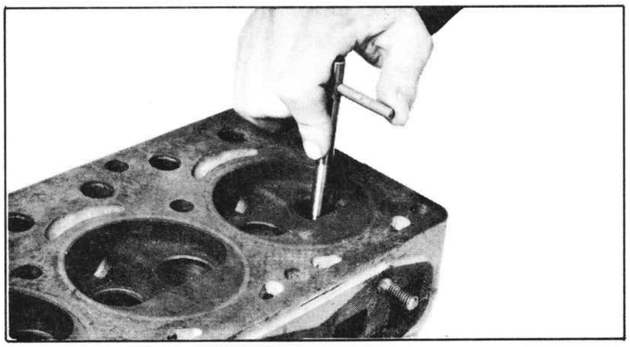


Fig. 30 - Installing the Pilot

5. Install the stone over the pilot as shown in Fig. 31; be careful not to exert pressure downward.

> *NOTE: Take very light cuts and check often so that only enough metal is removed to clean up the seat and give a continuously true surface.*

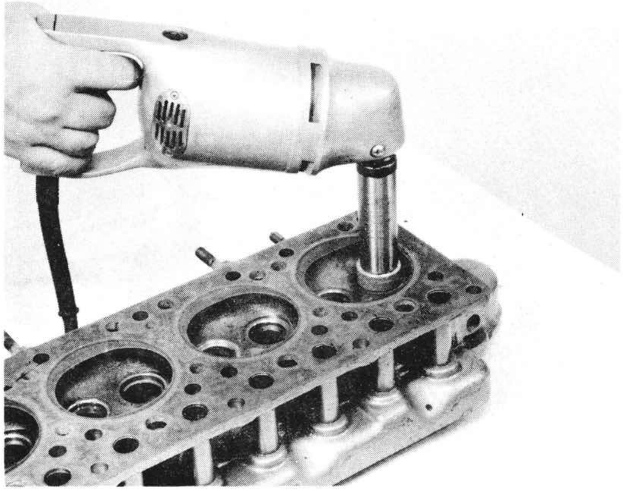


Fig. 31 - Refacing the Seat

POST-RESEATING INSPECTION

After reseating is completed, install a valve seat runout indicator as shown in Fig. 32. Seat runout must not exceed 0.002 inch.

After the valve seat runout is checked, the width and contact area of the valve - valve seat mating surfaces must be inspected. Apply a light coat of bluing to the face of the valve; insert the valve in its seat and turn it through an angle of 10 to 15 degrees. The area of the valve face from which the bluing has been removed will indicate the width of the seat and its location on the face, see Fig. 33. The contact area must fall in the middle of the face so that the two sharp edges of the seat may chip away any carbon or lead deposits which might interfere with the sealing action. If the contact area is too low on the valve face, as shown in Fig. 34, the outer or thin edges of the valve will become too hot through poor cooling contact. The remedy is to cut deeper with the seat grinder and narrow the seat as shown in Fig. 37.

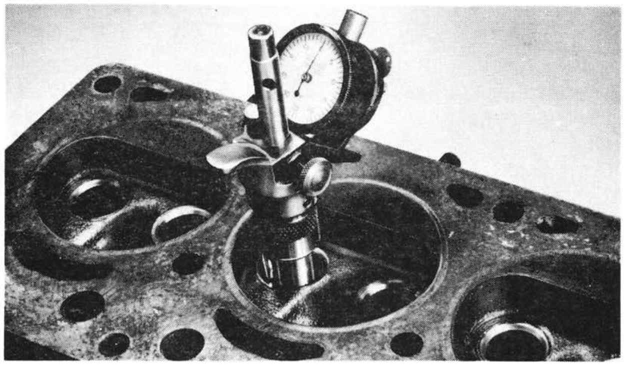


Fig. 32 - Checking Valve Seat Runout

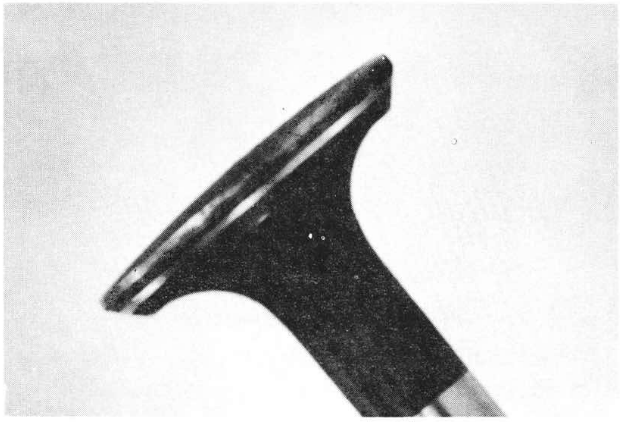


Fig. 33 - Checking Valve - Valve Face Contact

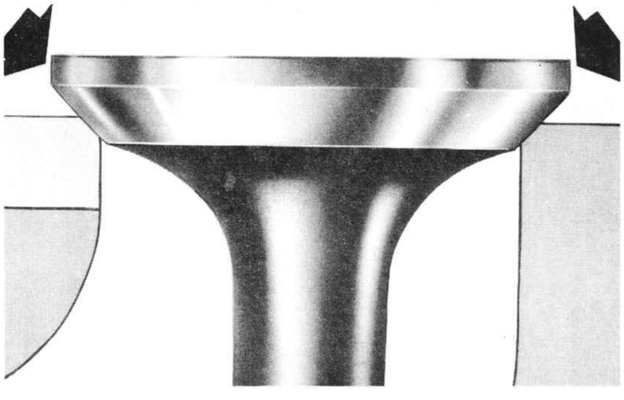


Fig. 34 - Contact Area Too Low

If the contact area is too high on the valve face, as shown in Fig. 35, the sharp edges of the seat do not contact the face, and carbon build-up is encouraged. A few light cuts with a 10° stone on 30° seats, or a 15° stone on 45° seats, will lower the location of the contact area.

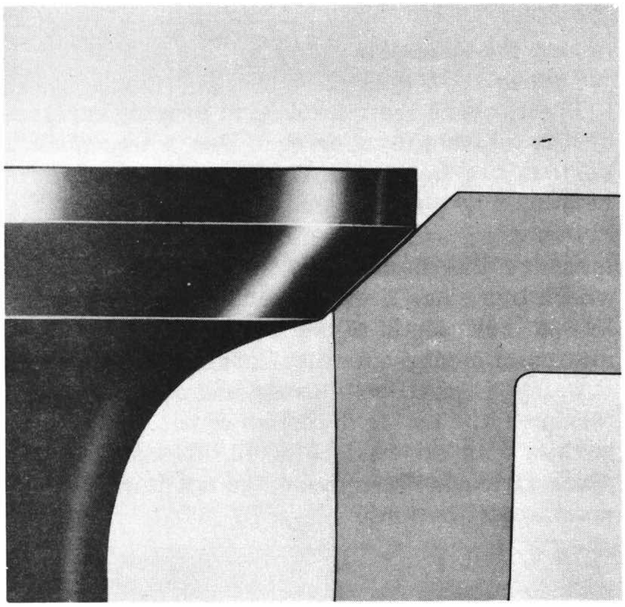


Fig. 35 - Contact Area Too High

Notice in Fig. 36 that the contact area is now lower on the valve face but it is too wide. This may result in a low valve closing pressure which would encourage formation of carbon deposits between the valve face and seat. The width of the contact area is an important factor in the life of the valve. The seat must always be narrower than the valve face. If a seat is too wide, it tends to collect excess carbon. If the contact area is too narrow, the transfer of heat from the valve face to the coolant will be less efficient. This may cause the valve to hammer down into the seat and decrease the amount of valve lash. The seat width listed in the engine specifications can be obtained by using a narrowing stone on the inside diameter of the seat as shown in Fig. 37. Fig. 38 shows a properly seated valve with and without valve seat inserts.

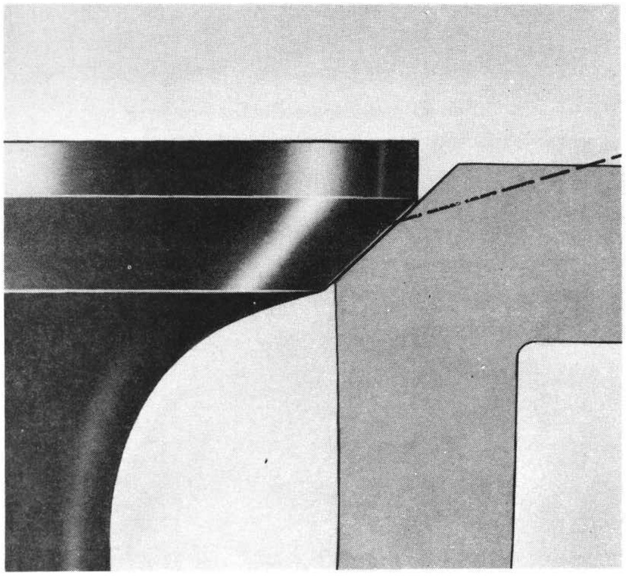


Fig. 36 - Lowering the Contact Area

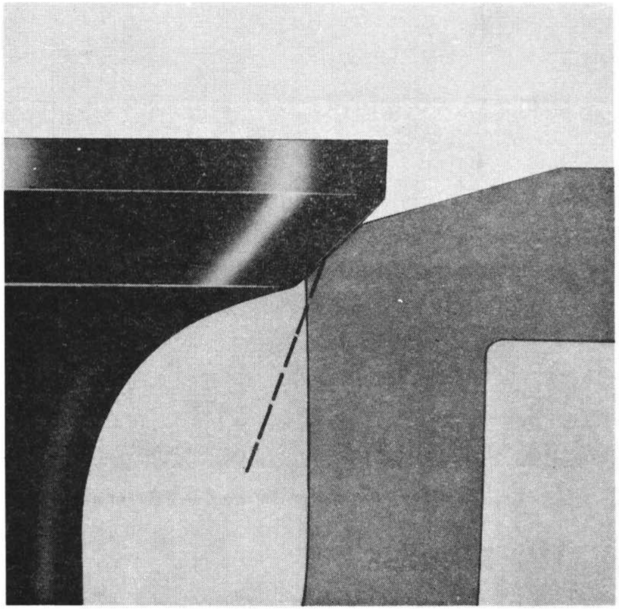


Fig. 37 - Narrowing the Contact Area

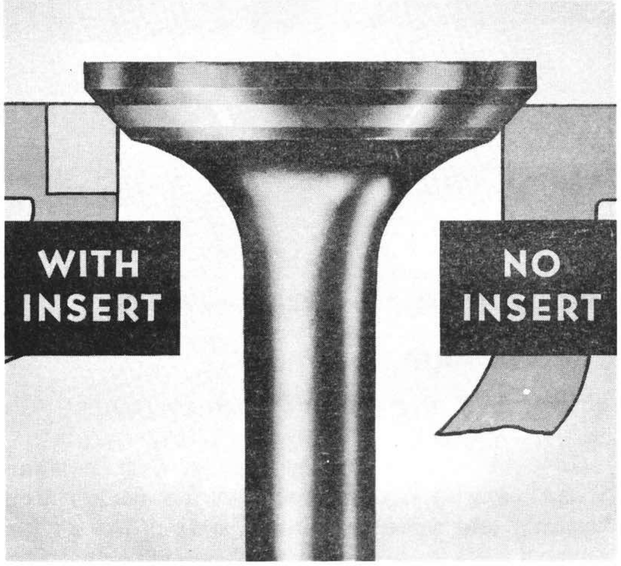


Fig. 38 - Properly Seated Valve

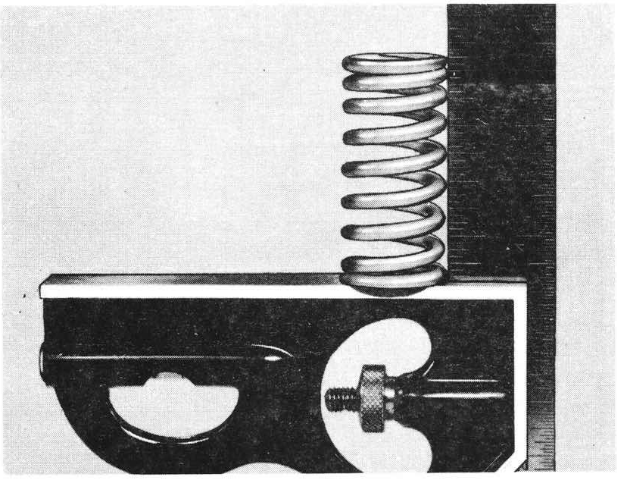


Fig. 39 - Checking Valve Spring For Squareness

VALVE SPRINGS

Check the spring with a square as shown in Fig. 39. Discard any springs that are not square. Measure the over-all free length of the spring and then place the spring in a suitable spring tester and compress the spring to its test length as shown in Fig. 40. Note the load indicated by the tester and replace any spring which is below specifications.

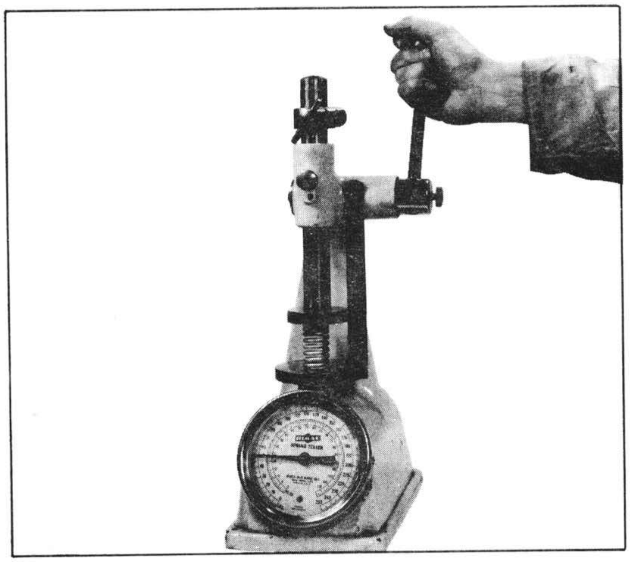


Fig. 40 - Testing Valve Spring Pressure

ROCKER ARM ASSEMBLY

INSPECTING THE ROCKER ARM ASSEMBLY

Inspect the assembly for excessive wear. Wear usually occurs between the rocker arm bushing and shaft and on the ends of the rocker arm. Check to see if any of the springs between the arms are broken or damaged.

Preparing the Assembly for Miking

The assembly should be completely disassembled and cleaned. Make sure that the parts are arranged in the same order as they were removed so that diameter comparisons can be made. Make sure that all oil passage holes are clean and open.

Miking the Assembly

First, check the rocker arm bearing surfaces of the shaft for scoring. Use a new shaft if serious scoring is found. Slight scoring may be remedied by polishing with crocus cloth.

Use a micrometer, as shown in Fig. 41, to measure the diameter of the shaft at the points where there has been rocker arm bearing wear. Use a new shaft if the diameter is less than minimum engine specifications.

Using a small-bore gauge and a micrometer, measure the inside diameter of the rocker arm bushings as shown in Fig. 42. Discard and replace all rocker arm bushings not meeting minimum specifications.

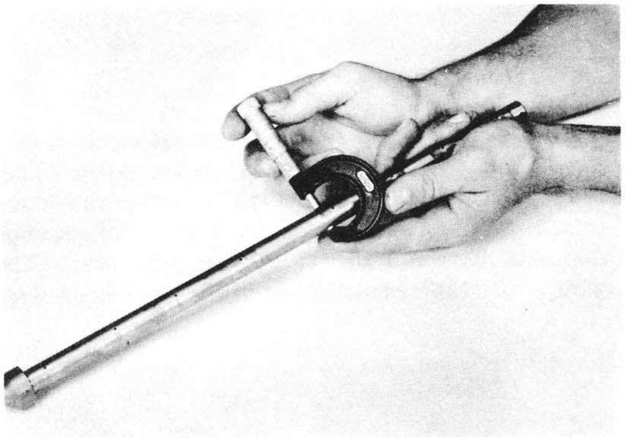


Fig. 41 - Miking the Rocker Arm Shaft

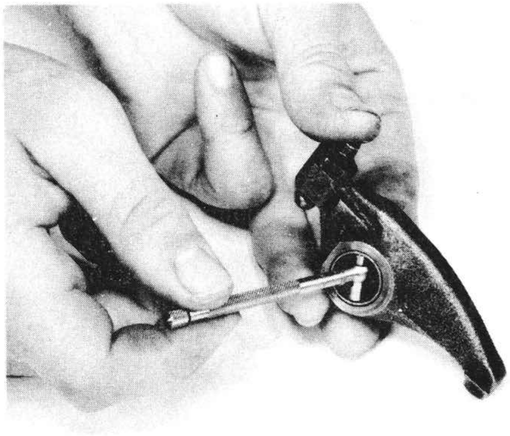


Fig. 42 - Miking the Rocker Arm Bushing

SERVICING THE ROCKER ARM ASSEMBLY

Slight wear or pitting of the rocker arm face may be corrected by grinding to the specified radius, using a special fixture provided with the valve grinding machine as shown in Fig. 43. Do not remove any more metal than is necessary to produce a smooth, bright surface. Follow the grinding machines manufacturer's instructions in this operation. If severely worn or pitted, replace with a new one.

For additional servicing information refer to the individual engine sections.

When reassembling the rocker arm assembly, follow the procedures outlined in the individual engine sections. Oil the bushings of all the rocker arms before assembly; check to insure that all oil passages are open and aligned. Make sure that each rocker arm lines up with its valve.

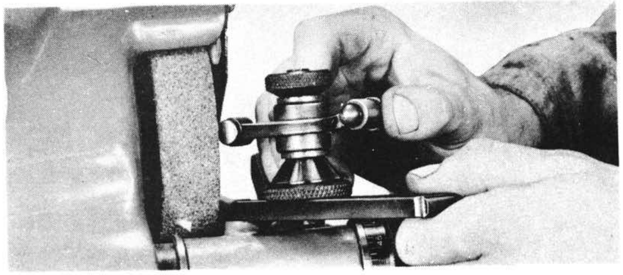


Fig. 43 - Refacing the Rocker Arm

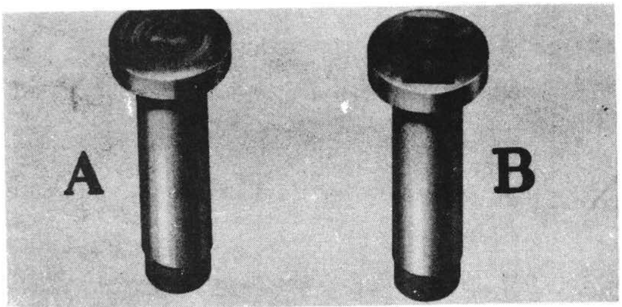


Fig. 44 - Tappet Wear Pattern

PUSH RODS AND TAPPETS

INSPECTING THE PUSH RODS AND TAPPETS

The push rods and tappets should be visually inspected for scoring and scuffing.

The mushroom shaped tappets can only be removed through the crankcase when the oil pan and the camshaft have been removed. After removal, examine each tappet in turn and check for excessive wear with a micrometer. Face markings illustrated in "B" Fig. 44 illustrates that the tappet has not been turning in its bore, while that illustrated "A" indicates satisfactory turning, thus ensuring even wear and satisfactroy rocker adjustment. Tappets which have not been turning must be replaced.

Examine the cup end of the push rods, discard those which show excessive wear. Also discard any push rods that are bent or damaged. Install all push rods in their original locations.

COMPLETION OF THE VALVE RECONDITIONING JOB

Thoroughly clean the cylinder head and blow out the valve ports and other openings with compressed air to remove all traces of grindings, and abrasives.

Lubricate the valve stems liberally with engine oil and install the valves as outlined in the individual engine sections. Replace any retainers, locks or caps when damage or excessive wear is apparent.

INSTALLING THE CYLINDER HEAD

Thoroughly clean the mating surfaces of the block and head and install a new head gasket. Tighten the head in the proper sequence WITH A TORQUE WRENCH, as outlined in the individual engine sections.

> *NOTE: Do not apply full torque in one application; tighten the head bolts and studs a little at a time, using the proper sequence until all of the studs are tightened down to the recommended torque.*

INSTALLING THE ROCKER ARM ASSEMBLY

Carefully insert the push rods through the holes in the head making sure that the push rods seat properly on the tappets. Lower the rocker arm assembly onto the head using care not to unseat the push rods. Tighten the assembly into position using the specified torque.

SETTING THE VALVE TAPPET CLEARANCE

Valve tappet clearance is very important as it affects both the tractor performance and engine economy. After installing the cylinder head set the valve tappet clearance as follows:

1. Make a cold tappet setting before starting the engine.
2. Operate the tractor for a period of time and then re-torque the cylinder head.
3. Bring the engine to operating temperature and make the final tappet setting.

GROUP I — SECTION A — PART 4

CYLINDER BLOCK ASSEMBLY SERVICING

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Cylinder Sleeve Servicing 1
Piston and Connecting Rod Assembly 5
Servicing the Crankshaft 10
Servicing the Cylinder Block 12

The cylinder block assembly, as referred to in this section, consists of the pistons, sleeves, wrist pins, connecting rods, crankshaft and block.

The text in this section is basic to most of our engines and is written to supplement the specific information given in the individual engine sections.

CYLINDER SLEEVE SERVICING

Whenever it is determined that the cylinders require servicing, a decision must be made whether or not to replace the sleeves. This decision is generally based on the maximum taper in the cylinder wall. A measurement of taper that is accurate enough to indicate whether a cylinder should be resleeved can be made before the pistons are removed from cylinders.

INSPECTING THE CYLINDER SLEEVE

Position the piston at the bottom of its stroke to facilitate the examination of the cylinder walls above the piston.

Scoring or Uneven Wear

As a first step in checking the sleeve, wipe it clean and examine it carefully for scoring and uneven wear (which shows up as dark, unpolished spots). Replace any sleeves that show evidence of scoring or uneven wear.

Cylinder Taper and Excessive Wear

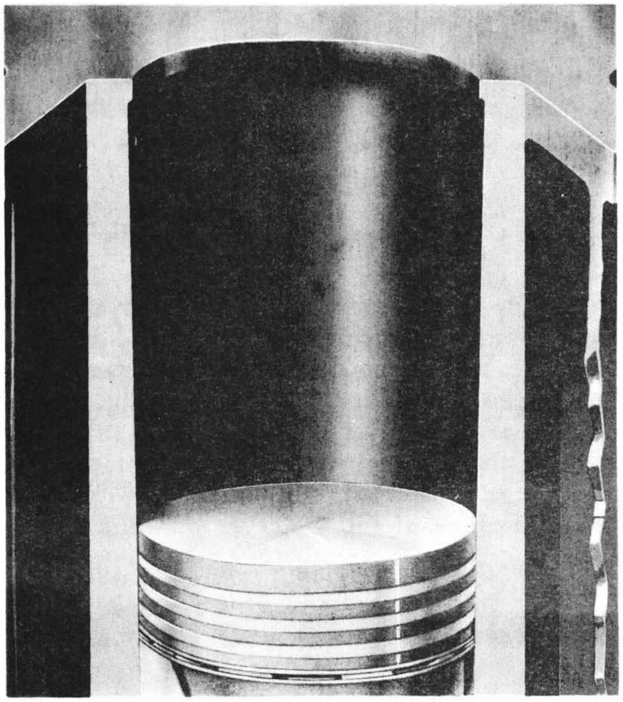

Fig. 1 - Measuring Cylinder Taper

Using an inside micrometer or a cylinder gauge, measure the sleeves for taper and excessive wear. To determine the amount of taper, measure the smallest cylinder diameter just above the piston (when the piston is at the bottom of its stroke), then subtract that reading from the largest diameter taken just below the highest point in the ring travel. The difference will be cylinder taper. See Fig. 1. Replace sleeves if measurements are not within engine specifications.

CYLINDER SLEEVE SERVICING

Ridge Removal

Clean the top of the cylinder block with a scraper or rotary steel brush; be careful to keep dirt from getting down into the valve ports and water jacket.

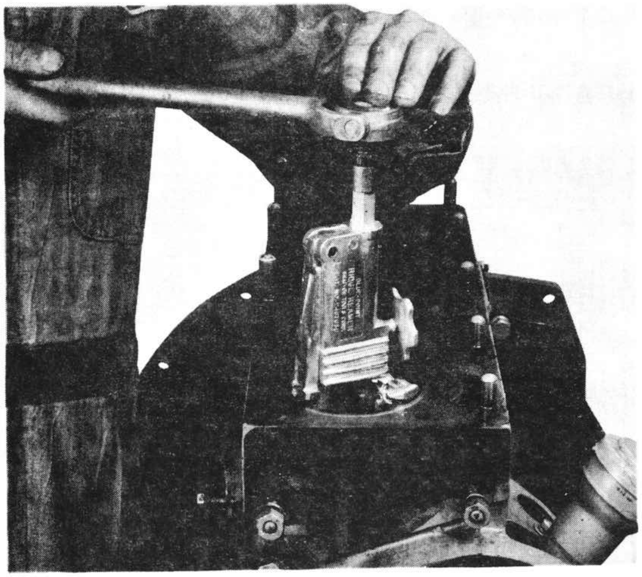

Fig. 2 - Removing Cylinder Ridge

After the top of the block has been cleaned, the cylinder ridge must be removed, as shown in Fig. 2, before the piston and rod assembly is taken out of the cylinder.

> *CAUTION: Use care when removing the ridge with a reamer, not to cut too deep into the sleeve. Never cut down into the ring travel area more than 1/32 of an inch. DO NOT USE A RIDGE REAMER ON CHROME LINED SLEEVES.*

Most of the wear occurring in a cylinder is in the top inch of the ring travel. As a cylinder wears, the upper outer corner of the top ring wears to fit the rounded shoulder formed at the top of the ring travel as shown in Fig. 3. If a new square-cornered ring is installed in the top groove without removing the cylinder ridge, the corner of the ring will strike the rounded lower surface of the ridge as shown in Fig. 4.

> *NOTE: Generally this causes a clicking noise and in some cases bends or breaks the second ring land, thus locking the second ring in its groove. See Fig. 5.*

When removing the ridge always leave the smoothest possible surface at the bottom edge of the cylinder wall surface where the ridge joins the ring travel.

> *NOTE: After the ridges have been removed, each piston should be brought to the top of its stroke and the cuttings wiped away being careful not to allow the cuttings to drop into the water jacket openings, manifold or into the valve ports.*

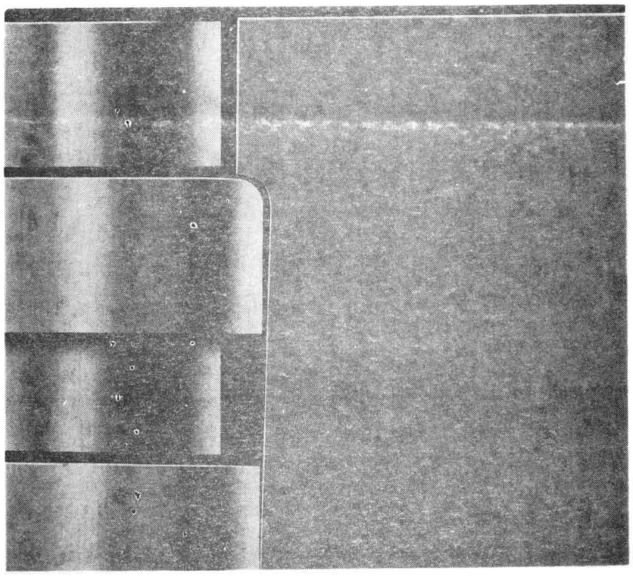

Fig. 3 - Top Compression Ring Wears Rounded

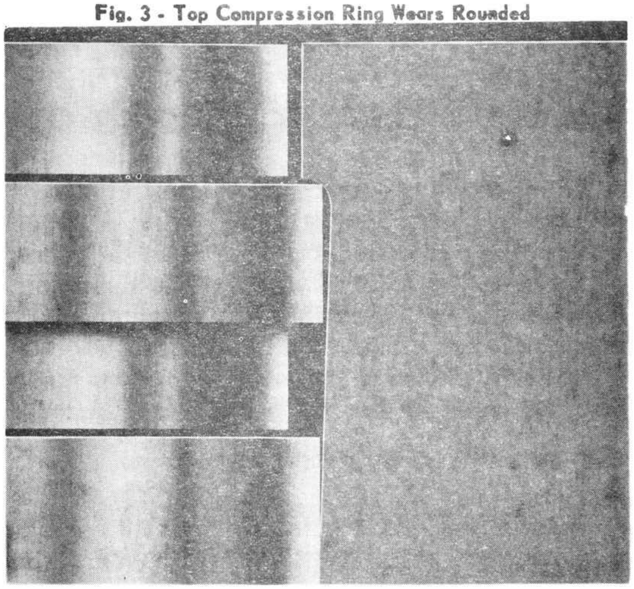

Fig. 4 - New Ring Striking Cylinder Ridge

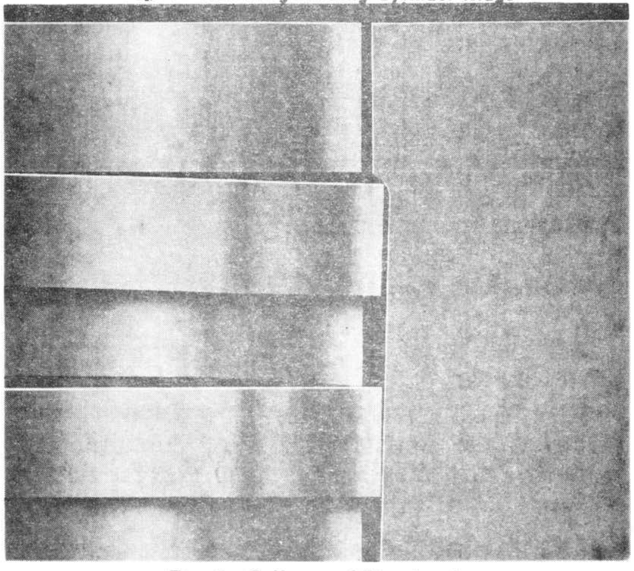

Fig. 5 - Collapse of Ring Land

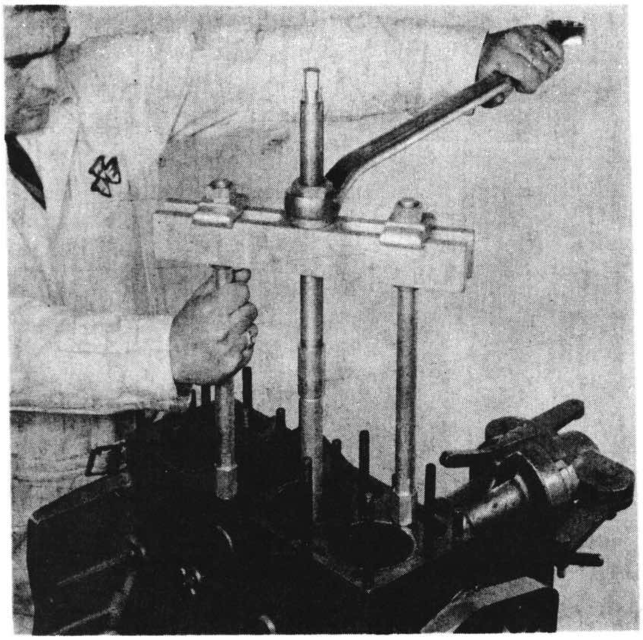

Fig. 6 - Pulling Cylinder Sleeve

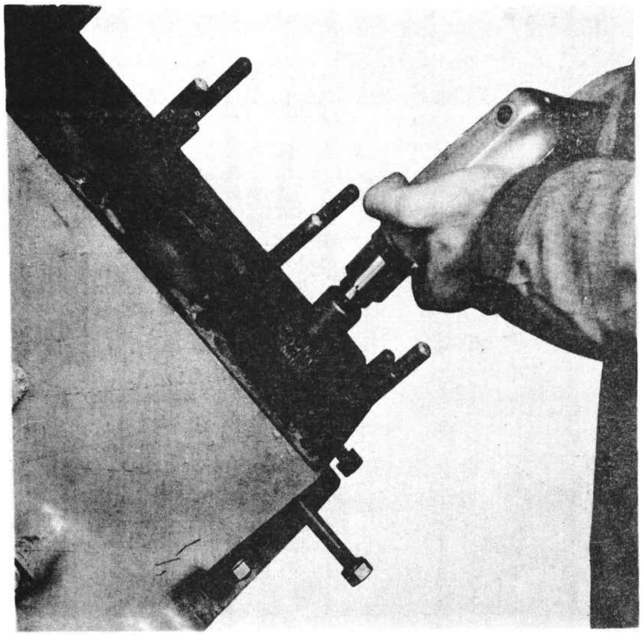

Fig. 7 - Cleaning Cylinder Sleeve Recess

INSTALLING THE CYLINDER SLEEVES

When the cylinder head and pistons have been removed, the cylinder sleeves may be pulled from the top as shown in Fig. 6.

The sleeve when installed correctly, will provide adequate clearance for the piston furnished with the assembly. If a sleeve is installed in a bore that is too small or that has not been properly cleaned, there is danger of distortion or collapse of the sleeve.

Wet Sleeves-MF 35 Gas, 50, 65, 85 Gas and LPG, 85 and 88 Diesel

Before installing the sleeves, remove any loose scale or rust from the water passages in the block. This will insure that contamination will not get on the sealing surfaces as the sleeve is inserted. Clean the sleeve bores in the block, as shown in Fig. 7, scraping or wire-brushing any rust or scale from the recessed seat at the top of the block. Using crocus cloth or "000" emery cloth, clean the tapered portion of the lower sealing area which guides the "O" ring seals into place.

> *CAUTION: Always use a circular motion when cleaning the lower sealing area with crocus cloth. Never leave vertical scratches as these will encourage leakage of coolant into the crankcase.*

Wash these areas with a suitable solvent and blow out with compressed air. Coat the sealing rings with brake fluid or vaseline and slip them over the lower end of the sleeves and into the grooves being careful not to have them twisted. Coat the entire sealing surface of the cylinder sleeve, as shown in Fig. 8, with brake fluid or vaseline and slip it into the block, being careful not to unseat the seals as they pass through the top hole in the block. Center the lower end of the sleeve in the lower hole in the block and carefully push the sleeve into place as shown in Fig. 9.

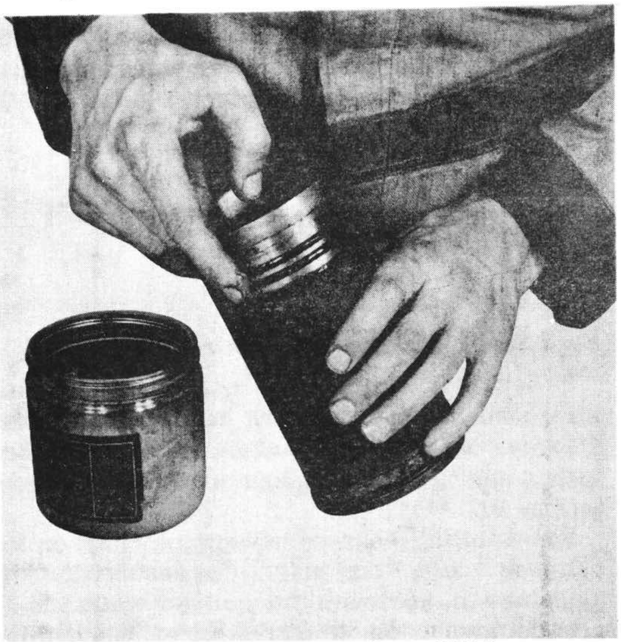

Fig. 8 - Lubricating Cylinder Sleeve "O" Rings

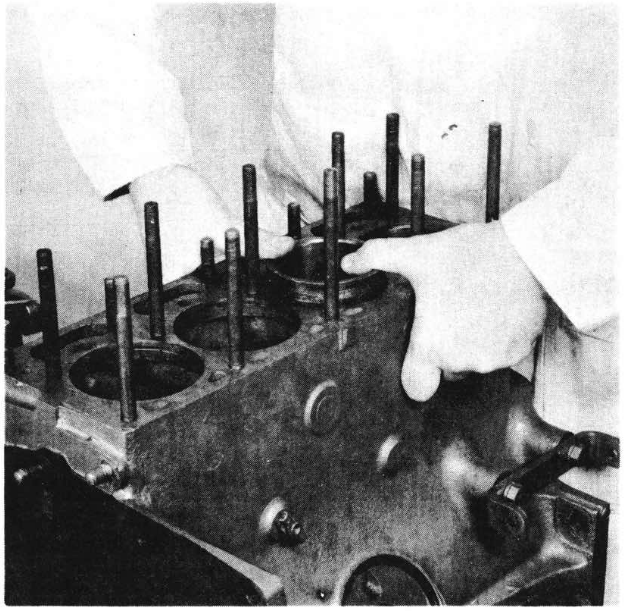

Fig. 9 - Installing Cylinder Sleeve

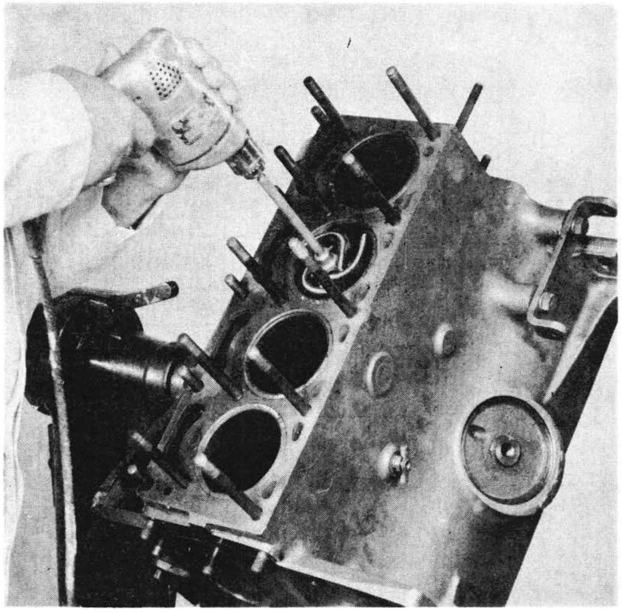

Fig. 10 - Breaking Cylinder Glaze

Dry Sleeves - TO 35 Diesel 23C Engine, MF 35 and 65 Perkins Diesel

The manner in which the dry sleeves fit the cylinder bores plays a very important part in the successful operation of the engine.

The efficiency with which heat is transferred from a sleeve to the coolant depends upon the fit of the sleeve. A sleeve fit too loosely does not make good contact with the cylinder block and results in a poor heat transfer. This can cause scuffing of both the cylinder wall and the piston rings.

A tight-fitting sleeve can be just as harmful as a loose-fitting sleeve. Refer to the individual engine sections for proper fit.

> *CAUTION: Chrome plated piston rings are not compatible with chrome plated cylinder liners, and the two should NEVER be used together.*

DEGLAZING

Hard Steel or Hardened Cast Iron Sleeves

If new piston rings are installed in engines with hard steel sleeves or hardened cast iron sleeves, the cylinder surface should be broken with a spring-loaded "glaze breaker" as shown in Fig. 10.

Some initial wear of new piston rings or the cylinder walls -- or both -- is essential if the rings are to mate with the cylinder walls and do a satisfactory job of controlling oil and sealing against blow-by. If the cylinder walls have the smooth surfaces of hard steel or hardened cast iron, new rings may "skate" over the surface, no wear will take place, the rings will not seat, and high oil consumption and blow-by will result.

When hardened cylinders are deglazed, they must be thoroughly cleaned. Too often deglazing is not performed carefully and the cleaning is not thorough.

Chrome Lined Sleeves MF 35 and 65 Perkins Diesel

DO NOT ATTEMPT TO DEGLAZE OR HONE CHROME LINED SLEEVES. Because the chrome lining is very thin, the liner will be damaged beyond repair if a cylinder hone or a "Glaze Breaker" is used. Refer to individual Engine Sections for further information.

DEGLAZING PROCEDURE

The following procedure has been found to produce satisfactory results.

1. With the piston and rod assemblies removed from the engine, a clean, dry rag or paper dampened with water should be carefully packed at the bottom of the holes to prevent abrasives and dirt, resulting from the deglazing operation, from getting onto the crankshaft.

2. Wipe the cylinders out with a clean cloth.

3. Swab the cylinder walls with SAE 10 engine oil.

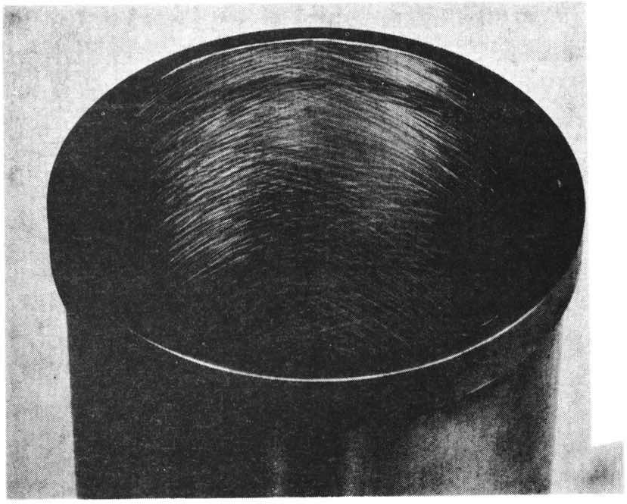

Fig. 11 - Cylinder Sleeve Cross-Hatch Pattern

4. Deglaze each cylinder with 10 to 12 complete strokes, moving the "glaze breaker" up and down in the cylinder rapidly enough to obtain a pattern where the crosshatching intersects at about 60° as shown in Fig. 11.

> *CAUTION: If too rapid a stroke is used, the pattern lines will become vertical resulting in excessive oil consumption.*

5. Clean the loose abrasive from the "glaze breaker" with a cloth before placing it in the next cylinder.
6. Repeat steps 3, 4 and 5 until all of the cylinders have been deglazed.
7. After deglazing, wipe as much as possible of the abrasive deposits from the cylinder walls, then swab each cylinder with clean SAE 10 oil and carefully wipe it out with a clean cloth. One swabbing-wiping operation is not sufficient. It will usually take three such complete operations; the important thing to remember is - - MAKE SURE THE CYLINDER BORE IS CLEAN.

> *CAUTION: Failure to clean the cylinders properly will leave abrasives that cause rapid wear and ring failure.*

PISTON AND CONNECTING ROD ASSEMBLY

INSPECTING THE PISTON

After the pistons have been removed from the cylinders, remove the rings with a piston ring tool, as shown in Fig. 12. Clean all carbon from the ring grooves with a ring groove cleaning tool, as shown in Fig. 13. Also make sure all oil holes are open and clean.

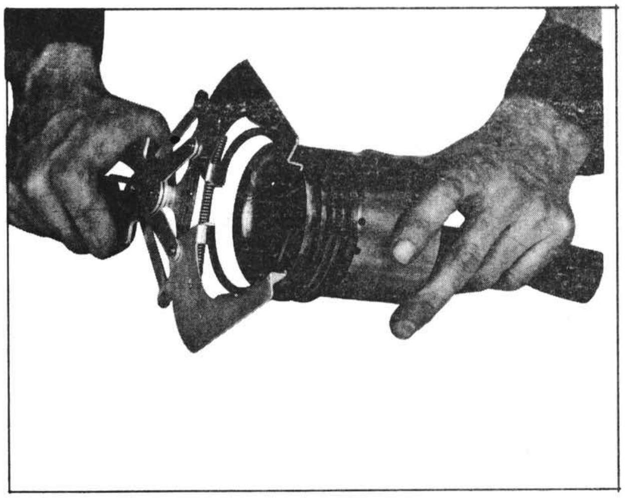

Fig. 12 - Removing Piston Rings

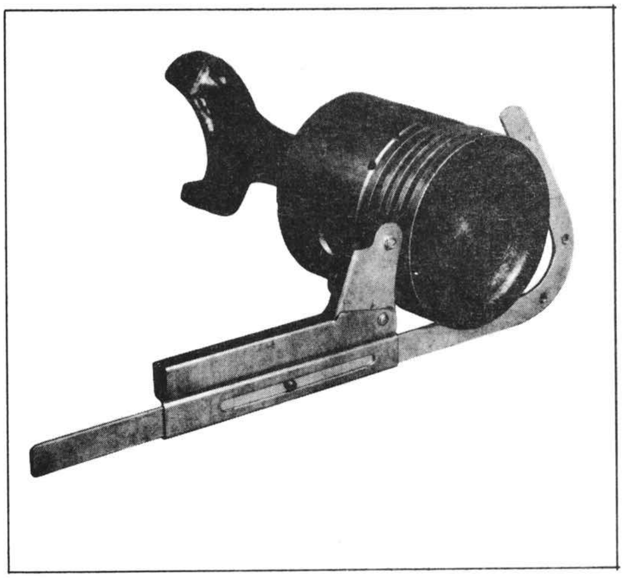

Fig. 13 - Cleaning Piston Ring Grooves

> *NOTE: Never attempt to clean the piston or ring grooves with a wire brush or wheel, as the piston and ring lands will be damaged.*

After the pistons have been thoroughly cleaned, inspect them for scuffing or scoring, worn ring grooves, bent or broken ring lands, collapsed skirt, cracks in the head or skirt, burned spots and fit in the cylinder bore. Discard any piston that is damaged or does not meet specifications.

SCUFFING AND SCORING

Inspect each piston carefully for scuffing and scoring. Fig. 14 illustrates a scored piston.

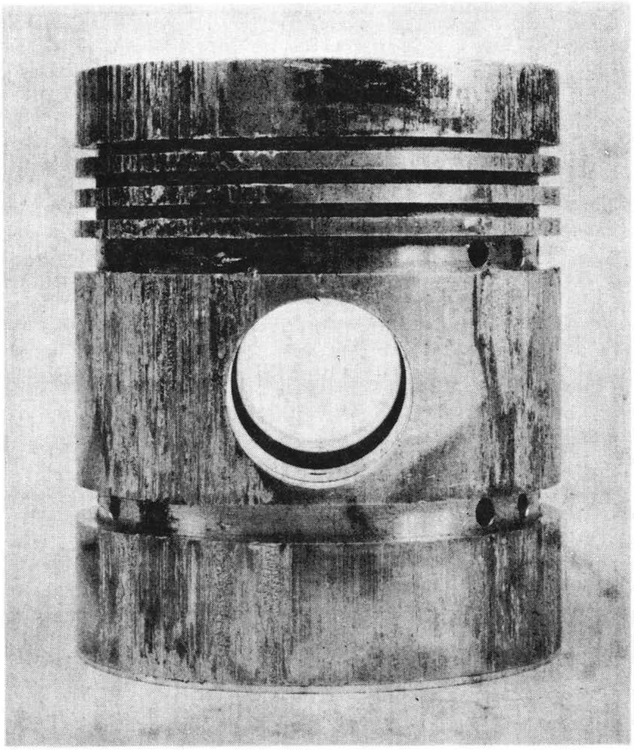

Fig. 14 - Scored Piston

IMPORTANT: If scuffing or scoring is evident, always determine the cause and correct it before completing the overhaul. If it is not corrected, the condition may be repeated after the engine is back in operation.

CHECKING THE RING LANDS AND GROOVES

The top groove of a piston wears more than any other ring groove and should always be checked for wear. This is particularly true of aluminum pistons. To check the ring lands and grooves, place a new ring in the groove and roll it around the piston. If the ring lands are bent (or distorted), the ring will bind in the ring groove or will show looseness. See individual engine sections for minimum and maximum groove clearance specifications. Excessively worn grooves are obvious when a feeler gauge is inserted beside the ring as shown in Fig. 15. If the clearance between the side of the ring and the wall of the groove exceeds specifications when measured at a point 1/16 of an inch from the outside diameter of the piston groove, the piston must be replaced. See Fig. 16.

NOTE: Ring grooves wear unevenly; greatest wear occurs in the areas of the piston that run the hottest. For this reason, when a ring groove is being checked for wear, always check at more than one point around the piston.

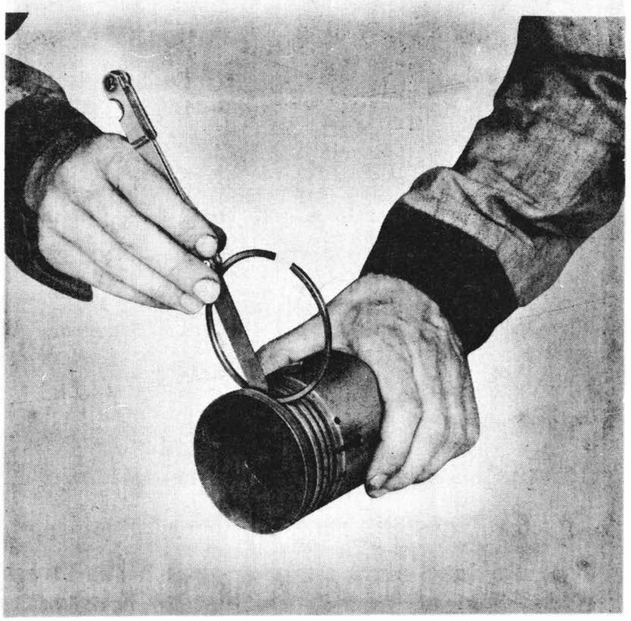

Fig. 15 - Measuring Piston Ring Side Clearance

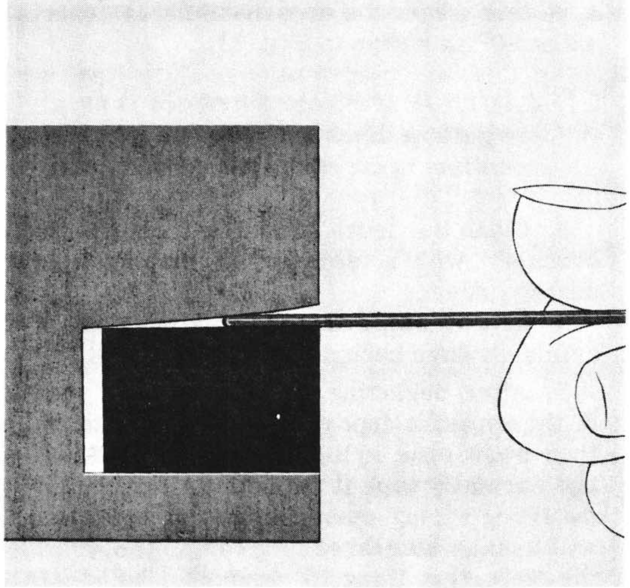

Fig. 16 - Measuring Ring Land Wear

The condition of the top compression ring, top groove and the upper end of the cylinder has a very definite influence on the performance of the engine. These parts of an engine are so critical that excessive wear, damage, or improper installation will permit high oil consumption and cause customer complaints.

MIKING THE PISTON SKIRT

Measure each piston with a micrometer to make sure the piston skirt is not excessively worn or collapsed. Measure at right angles to the piston pin and determine the top piston skirt diameter and the bottom piston skirt diameter, see Fig. 17.

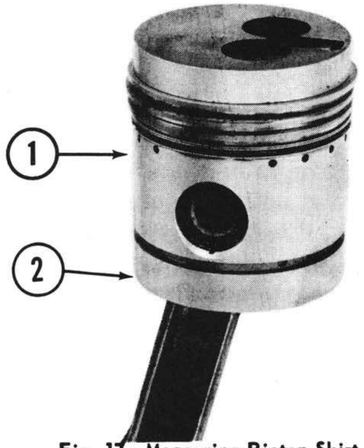

Fig. 17 - Measuring Piston Skirt Diameter
1. Piston skirt top 2. Piston skirt bottom

CHECKING THE PISTON FIT IN SLEEVE

The clearance between the piston and the cylinder sleeve is determined with a thickness gauge attached to a tension scale. See individual engine sections for proper thickness gauge and required pounds pull. The thickness gauge should be 1/2 in. wide and long enough to extend down into the sleeve the full length of the piston. The piston fit should be checked with the pistons and sleeves at normal room temperatures (70°F.) In a worn sleeve the piston clearance should be checked in the upper, worn portion of the sleeve.

In checking the piston fit, the thickness gauge is placed against the side of the sleeve and the piston inserted upside down in the sleeve the full length of the piston, see Fig. 18. The thickness gauge should be exactly 90 degrees (right angle) from the piston pin hole and in line with the thrust surface on the power thrust side of the sleeve. The thickness gauge should be withdrawn by pulling on the tension scale. Observe the pull required as the gauge is removed. Install new piston and sleeve sets if the pull required is less than specifications.

CHECKING THE PISTON AND CONNECTING ROD ASSEMBLY

LOOSENESS AT THE WRIST PIN

Place the piston head on a flat surface, as shown in Fig. 19 and rock the connecting rod back and forth towards each end of the wrist pin. If wear is evident, disassemble and follow the steps listed.

1. Measure the wrist pin diameter with a micrometer. Discard pins that are not within specifications.

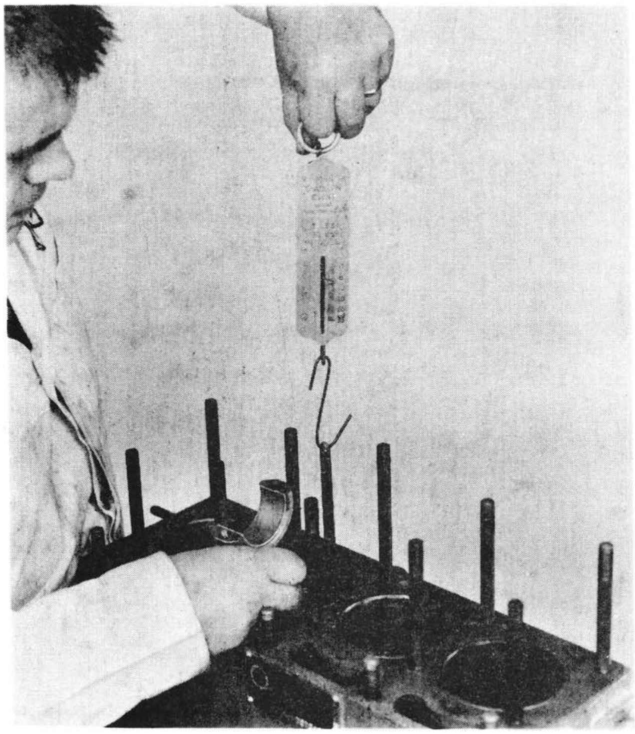

Fig. 18 - Checking Piston Fit

2. Measure the wrist pin hole in the piston with a bore gauge and micrometer or with a new pin. If oversized pins are not available, discard pistons that are not within specifications.

> *NOTE: Where oversized piston pins are available, hone the piston pin holes for the new diameter. See individual engine sections for specifications and proper pin fit.*

3. To check each piston pin - connecting rod bushing fit refer to the specific engine servicing section.

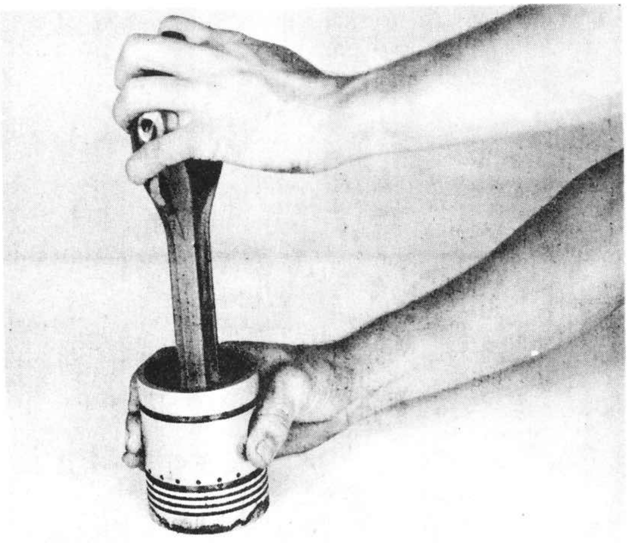

Fig. 19 - Checking Wrist Pin Fit

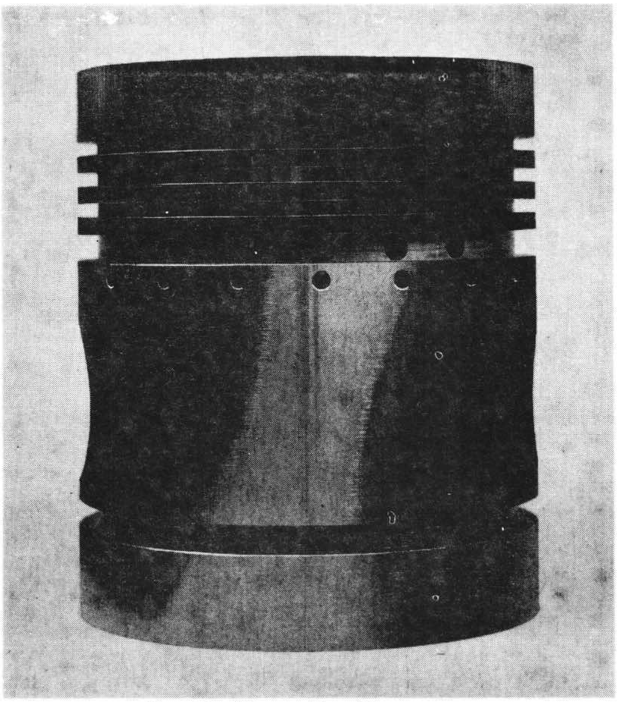

Fig. 20 - Uneven Wear Pattern

CHECKING CONNECTING ROD ALIGNMENT

Always check connecting rod alignment. Fig. 20 shows an uneven wear pattern on a piston, caused by a bent or twisted connecting rod.

To check connecting rod alignment, proceed as follows:

1. Replace the wrist pin and bushing if worn; a worn pin or bushing will give a false reading.

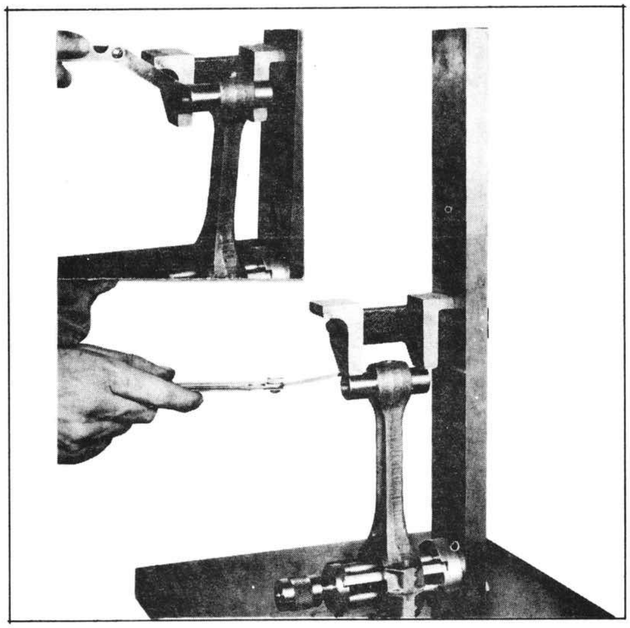

Fig. 21 - Checking Connecting Rod Alignment

2. Install the piston pin.

3. Remove the connecting rod bearing and place the assembly on an alignment fixture, see Fig. 21.

> *NOTE: To straighten a bent connecting rod, bend the rod the same distance past the center (In the opposite direction of the original bend) then bring the rod back into proper alignment. This will relieve the stress and assist in preventing the rod from again becoming misaligned.*

SERVICING THE PISTON AND CONNECTING ROD ASSEMBLY

CONNECTING ROD

Bushing Replacement

To install a new connecting rod bushing, carefully align the oil hole of the new bushing so that it indexes with the oil hole in the connecting rod. Press into position as shown in Fig. 22. Refer to the individual engine sections for further information.

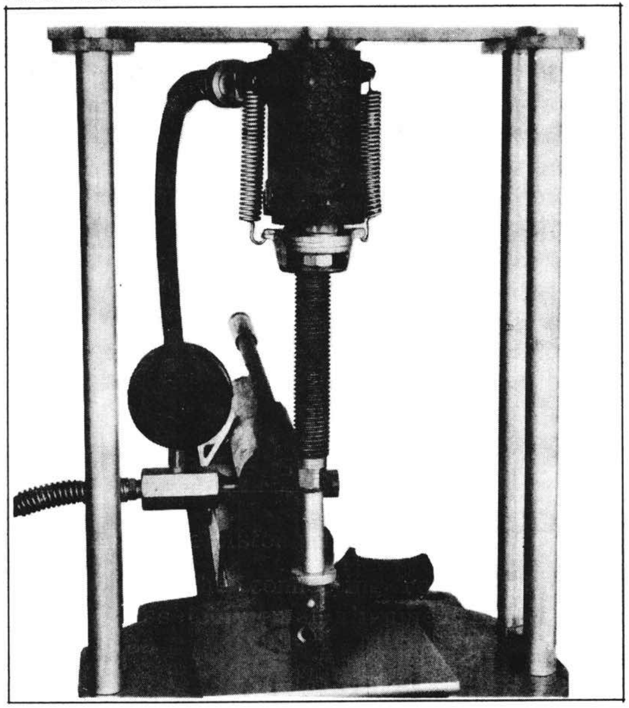

Fig. 22 - Installing Connecting Rod Bushing

Honing a New Bushing

If the connecting rod wrist pin bushing requires honing as shown in Fig. 23, make sure that a hone made by a reliable manufacturer is

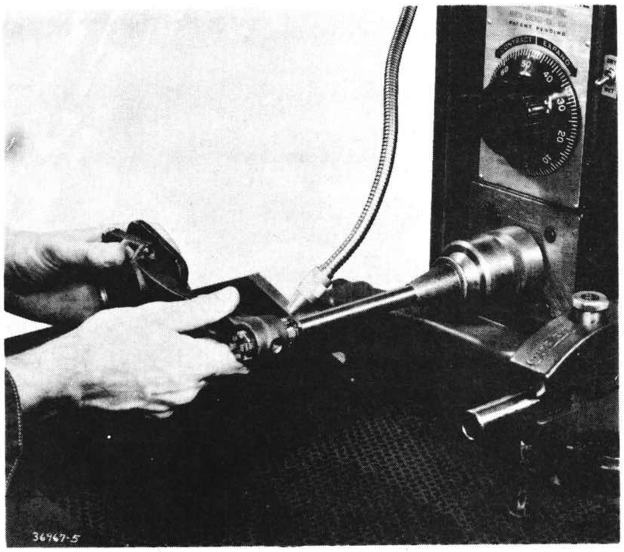

Fig. 23 - Honing Connecting Rod Bushing

used and that it is in good condition. Follow the manufacturer's recommendations and hone to engine specifications.

NOTE: Use extreme care when honing the bushing. Do not remove too much material.

PISTON SERVICING

Checking Ring Gaps

Before installing new rings on a piston, check all rings for proper ring gap. Each ring, one at a time, should be pushed down to the bottom of its cylinder with an inverted piston and the ring gap checked with a feeler gauge as shown in Fig. 24. If the gap is too small, the ring may be placed in a fixture designed for this purpose and its ends filed until the correct gap is obtained. See engine specifications for proper gap clearance.

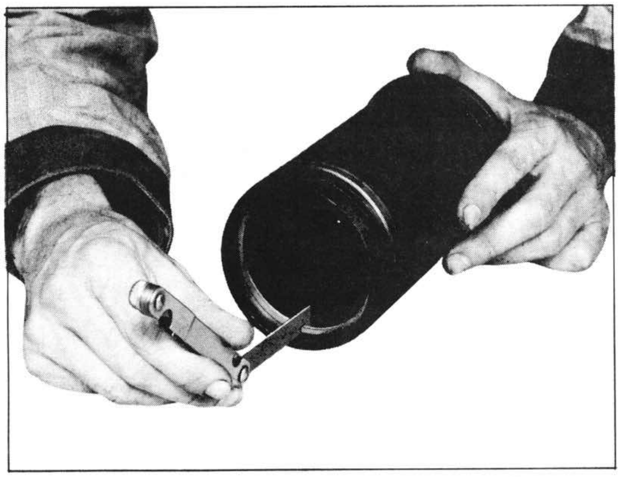

Fig. 24 - Checking Ring Gap

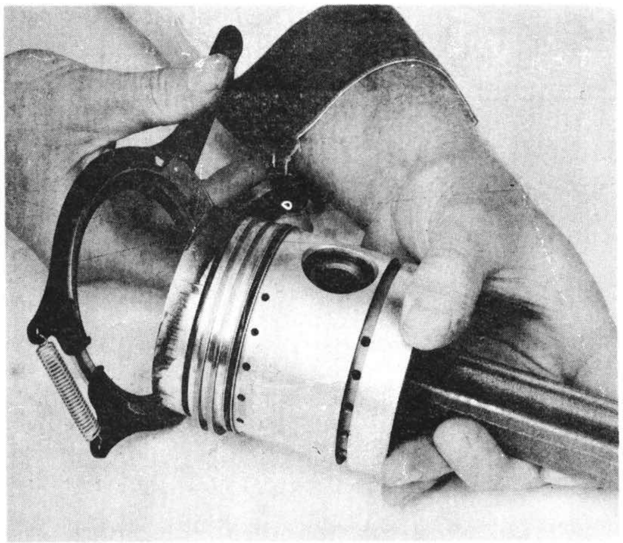

Fig. 25 - Installing Piston Rings

Installing Piston Rings

Always install rings on the piston with a ring expander tool, as shown in Fig. 25. To install the rings, the ring should be placed in the expander and expanded just enough to slip over the piston so that it may be positioned in its respective ring groove.

NOTE: Make sure that tapered compression rings are positioned with side marked "top", or "T", toward the head of the piston.

With each new compression ring installed in its groove and the face of the ring flush with the face of the ring land, it should be possible to insert a feeler gauge beside the ring completely to the bottom of the groove, see Fig. 26. Refer to engine specifications for minimum clearance. Oil Rings must be free in the groove.

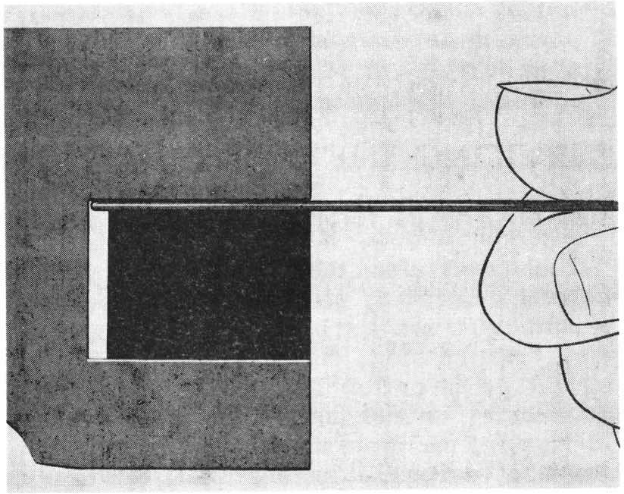

Fig. 26 - Checking Minimum Piston Ring Clearance

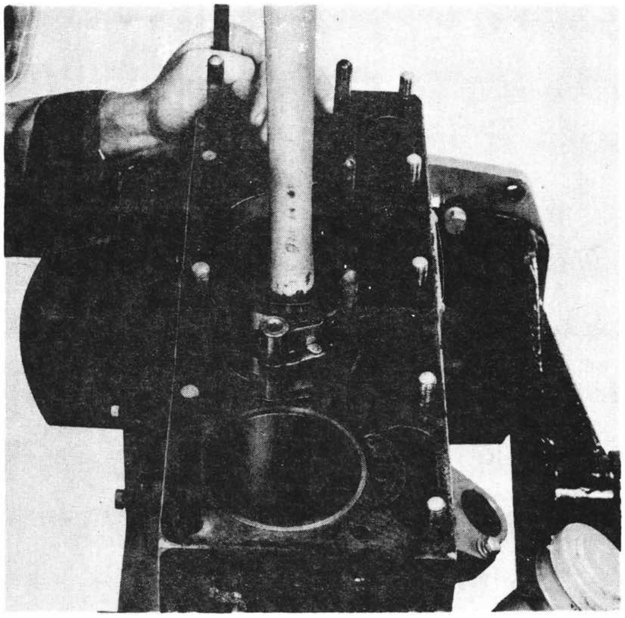

Fig. 27 - Piston Ring Compressor

REINSTALLATION OF PISTON AND CONNECTING ROD ASSEMBLY INTO SLEEVE

After the rods, pistons, and rings have been reassembled, they should be reinstalled in the engine. It is extremely important to make sure that parts which are used again are rematched (piston pins put back in same rods and pistons from which they were taken) and that the assemblies go back into the same cylinders from which they were removed. Rings should be positioned so that gaps are uniformly spaced around the piston. A piston-ring compressor should be used to compress the piston rings so that they will slip easily into the sleeves, see Fig. 27.

> *IMPORTANT: Before putting the piston-ring compressor into place, the piston-ring and rod assembly should be dipped in heavy oil, or in castor oil, to provide initial lubrication.*

SERVICING THE CRANKSHAFT

CRANKSHAFT INSPECTION

Thoroughly clean the crankshaft in a suitable solvent. Carefully clean the oil channels with a suitable brush and blow out with compressed air. All bearing journals on the crankshaft should be inspected for forms of wear such as scoring or ridging. If any such evidence is visable, the crankshaft is unfit for use and must be reground. Installation of new bearing inserts on a badly worn, scored or ridged bearing journal will result in very short bearing life and may possibly score the journal so badly that it will be impossible to recondition the shaft by regrinding.

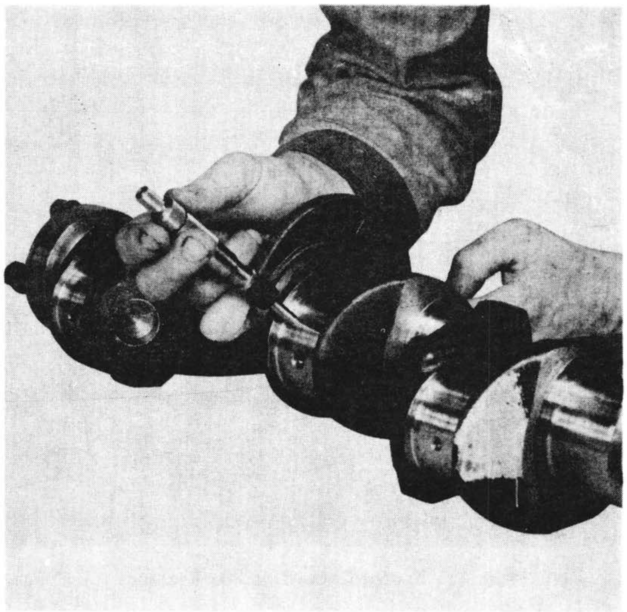

Fig. 28 - Miking the Crankshaft

BEARING JOURNALS

If the visual inspection of the shaft shows that it is in good condition, the bearing journals should be checked for wear and out of roundness with a micrometer, as shown in Fig. 28. See engine specifications for journal diameters. Measure each journal at a minimum of four places to determine the size and the amount worn out of round. Measure each end of the journal to determine the amount of taper. If any of the journals are more than .0015 in. out of round, or the taper wear exceeds .001 in., the shaft is not suitable for use and must be reground.

> *NOTE: When reconditioning a crankshaft, do not remove any more metal than is necessary; however, remove enough metal so that the closest undersized bearing may be properly installed. Never grind the crankshaft less than smallest size bearing available.*

If out of roundness is present in any degree, the bearings must be fitted with the proper clearance over the largest diameter of the journal. Full bearing life cannot be expected with this condition existing.

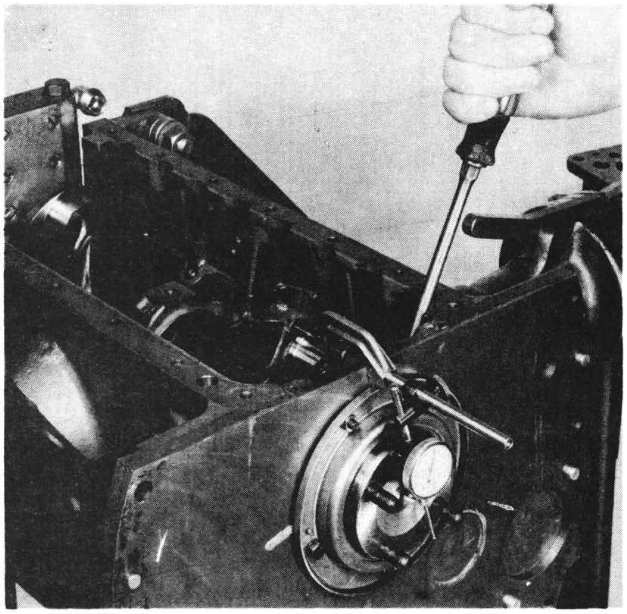

Fig. 29 - Checking Crankshaft End Play

CRANKSHAFT END PLAY

With a suitable tool, force the crankshaft endwise as far as it will go and measure the clearance at the end or at the end thrust bearing with a dial indicator or a feeler gauge, see Fig. 29. See engine specifications for proper clearance.

CRANKSHAFT BEARING OIL CLEARANCES

Oil clearance is the distance between the crankshaft journal and the bearing insert when installed. It is very important for proper engine operation that these clearances be maintained according to engine specifications.

CHECKING OIL CLEARANCES

The recommended method for checking oil clearance is by using Plastigage. To determine the clearance, follow the steps listed.

NOTE: When checking main bearing clearances with the engine in a position where the bearing caps are supporting the weight of the crankshaft and flywheel, keep all main bearing caps tight except the one being checked. Also support the weight of the crankshaft so that it will not cause an erroneous reading.

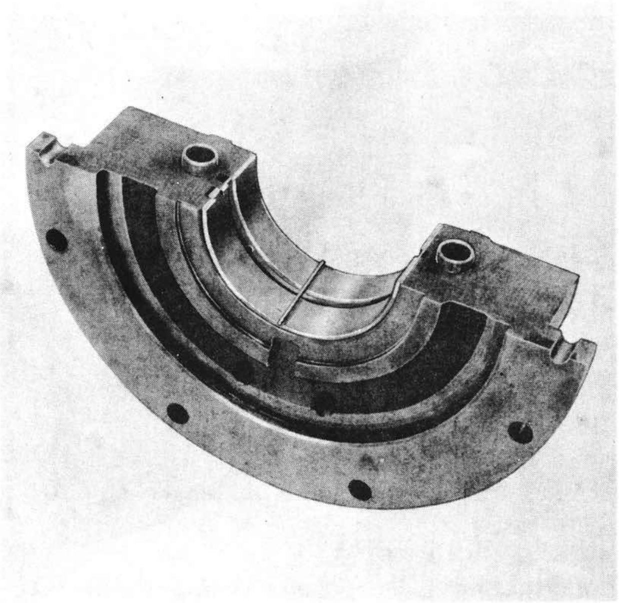

Fig. 30 - Installing Plastigage

To support the crankshaft, place a jack under the counterweight adjoining the bearing that is being checked, or place a thin rubber pad between the main bearing or bearings adjacent to the one being checked.

1. Remove the bearing cap and wipe the oil from the bearing insert and crankshaft journal.

2. Rotate the crank about 30° from bottom dead center. Place a piece of Plastigage the full width of the bearing insert as shown in Fig. 30, about 1/4'' off center and reinstall the bearing cap. Tighten the bolts to specifications.

CAUTION: Do not rotate the crankshaft after positioning the Plastigage and tightening the bearing cap. This further flattens the Plastigage and throws off the clearance measurement.

3. Remove the bearing cap. The flattened Plastigage will be found adhering to either the bearing shell or the crankshaft.

4. Compare the width of the flattened plastigage at its widest point with the chart on the plastigage envelope as shown in Fig. 31 and determine the clearance.

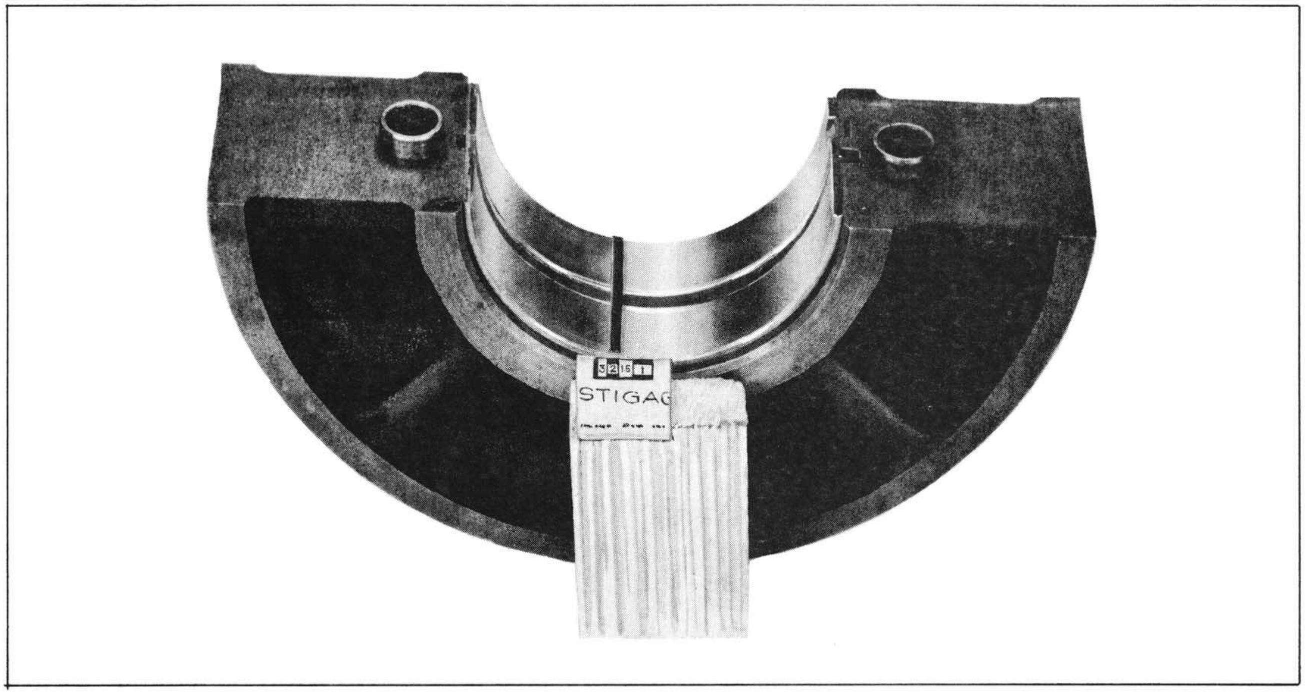

Fig. 31 - Measuring Plastigage with Envelope Provided

MAIN BEARINGS, OIL SEALS, CAMSHAFT, AND CAMSHAFT BEARINGS

Because the above mentioned items differ from engine to engine, they are covered in the individual engine sections.

SERVICING THE CYLINDER BLOCK

Any time that the engine is torn down, the block should be thoroughly cleaned and inspected. The following is a list of the operations that should be performed.

1. Thoroughly clean the block with a suitable solvent and remove the old gasket material from the machined surfaces.

2. Clean the coolant passages of all rust and mineral deposits.

3. Remove all of the pipe plugs which seal the oil passages; thoroughly desludge the oiled sections and blow out all passages, bolt holes, etc, with compressed air.

4. Make sure the threads in the cylinder block are clean and not damaged. Thread damage or dirt may cause a false torque reading. Use a tap to true-up threads and remove any deposits.

5. After the block has been thoroughly cleaned, make a check for cracks.

NOTE: Minute cracks not visible to the naked eye may be detected by coating the suspected area with a mixture of 25% kerosene and 75% light motor oil. Wipe the area dry and immediately apply a coating of zinc oxide dissolved in denatured alcohol. If cracks are present the coating will become discolored at the defective area. Replace the block if it is cracked.

6. Check the surface warpage of the block with a straight edge and feeler gauge as shown in Fig. 32. Check all machined gasket surfaces for burrs, nicks, scratches or scored areas.

7. Replace any expansion-type plugs that show evidence of leakage.

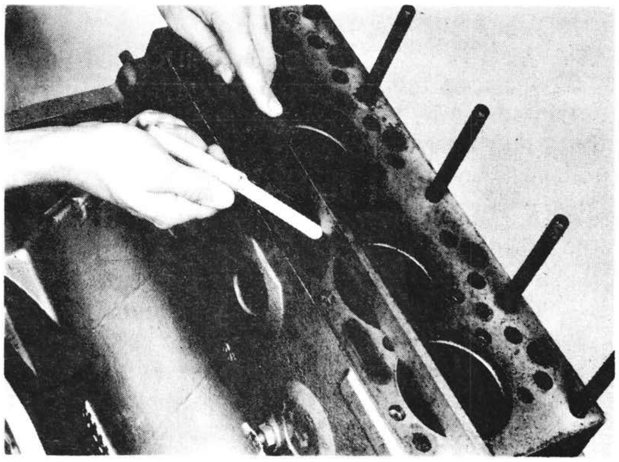

Fig. 32 - Checking Engine Block For Warping

GROUP I — SECTION A — PART 5

COOLING SYSTEM SERVICING

Engine cooling is basically the dissipation of heat from the cylinder walls. This is accomplished in Massey-Ferguson tractors by using a pressurized, forced circulation cooling system. This system is composed of a pump, radiator, thermostat and a fan.

COMMON COOLING SYSTEM PROBLEMS

Following are some of the more common troubles found with tractor cooling systems.

1. Loose or damaged fan belt - Inspect the fan belt for looseness or damage. Replace fan belts that are frayed or damaged. See the individual engine sections for proper fan belt deflection.

2. Clogged air passages in the radiator - Foreign matter in the air passages of the radiator, reduce the cooling efficiency of the fan and the radiator. These passages must be kept clean and open for proper cooling.

3. Clogged water passages in the radiator - The water passages in the radiator may become clogged with silt, mineral deposits, or other foreign material. Normally the radiator can be returned to full efficiency, by thoroughly flushing the radiator with a suitable cleaning agent.

4. Faulty thermostat - A thermostat that is not operating properly may cause overheating, or underheating. Both conditions are harmful.

5. Collapsed or clogged radiator hose - As the radiator hose becomes old, the inner lining may become flabby or tear loose. These pieces restrict the water passages and sometimes plug the passages completely.

6. Scaled or clogged water jackets - Whenever an engine is completely overhauled, the water passages must be thoroughly examined and all loose scale removed. Use of good rust inhibitors keep this problem to a minimum.

7. Frequent filling of the radiator - If frequent filling of the radiator is required, the cooling system should be carefully examined to determine the cause.

PREPARING THE COOLING SYSTEM FOR INSPECTION

If the results of any extensive inspection are to be accurate, the cooling system must first be prepared for inspection as follows:

1. Check the cooling system for external leaks.
2. Make sure that the deflection of the fan belt is correct.
3. Fill the radiator to the proper level.
4. Check the operation of the thermostat. This may be done by starting the engine and watching the coolant through the filler cap opening while the engine is still cold. If the coolant is circulating, the thermostat is stuck in the open position. When the engine is warm and the coolant does not circulate, the thermostat is stuck in the closed position. See page 3 for thermostat checking procedure.
5. Start the engine, and run until the coolant reaches ''operating temperature''.

INSPECTING THE COOLING SYSTEM

WATER PUMP

See the individual Engine Sections, Group I.

HOSES, CONNECTIONS AND GASKETS

1. Inspect all of these areas for signs of leaking.
2. Inspect all connections for tightness.
3. Replace all hoses which are old and show signs of deterioration.

ENGINE WATER JACKET

1. Reverse flush the engine water jacket. When the engine has been left dry for several days, be sure the cooling system is thoroughly cleaned before placing the engine back into operation.

RADIATOR CAP

1. Make sure that the radiator cap is the pressure type designated in tractor specifications.

2. Make sure the action of the spring loaded valve is free and that all gaskets are serviceable. See Fig. 1.

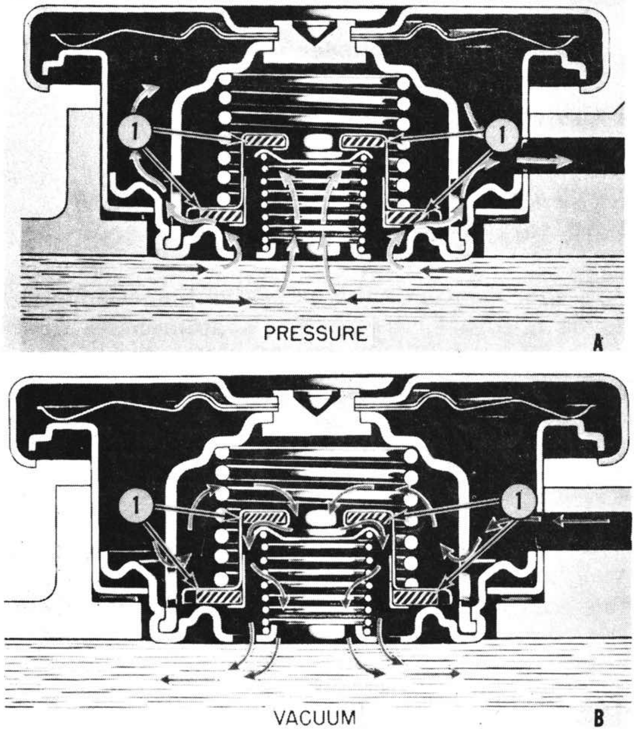

Fig. 1 Typical Pressure Cap
1. Gasket

RADIATOR

1. Inspect the air passages of the radiator for clogging.
2. Inspect the radiator for evidences of coolant leaks.
3. If reverse flushing equipment is not available, the radiator may be removed and taken to a dependable radiator shop for a complete job of cleaning or reconditioning.

CLEANING THE COOLING SYSTEM

1. Using compressed air in reverse direction of normal air flow, blow out any foreign materials which may have collected between the fins of the radiator.
2. A badly rust-clogged cooling system as shown in Fig. 2 will often be indicated by overflow loss or by abnormally high temperatures. This may be corrected by reverse flushing using a dependable cleaning compound. After cleaning and flushing, fill the system to the correct level with the proper coolant.

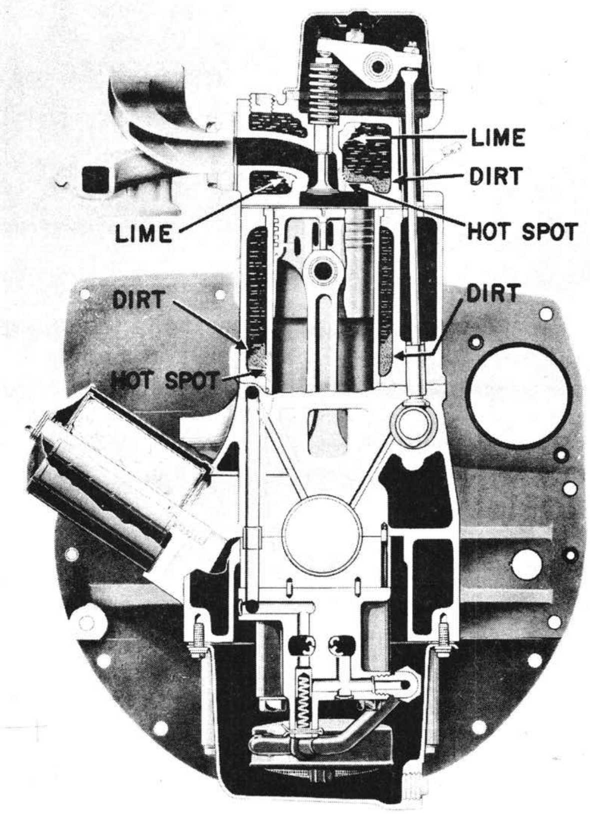

Fig. 2 Cooling System Deposits

NOTE: It is advisable to use soft water and a dependable rust inhibitor in the cooling system. This practice eliminates many of the lime and mineral deposits. Use permanent type anti-freeze if necessary.

REVERSE FLUSHING THE RADIATOR

1. Disconnect the radiator hoses between the engine and the radiator at the engine.
2. Install a serviceable radiator cap.
3. Connect the flushing nozzle into the lower hose. See Fig. 3.
4. Fill the radiator through the bottom hose.
5. Gradually apply air pressure through the flushing nozzle so that the radiator will not be damaged by a quick air blast.
6. Shut off the air supply and refill the radiator. Gradually increase the air introduced into the radiator.

NOTE: Continue steps 4, 5 and 6 until a clean stream runs out of the upper radiator hose.

7. Remove and clean the radiator cap. Make sure the spring loaded valve action is free.

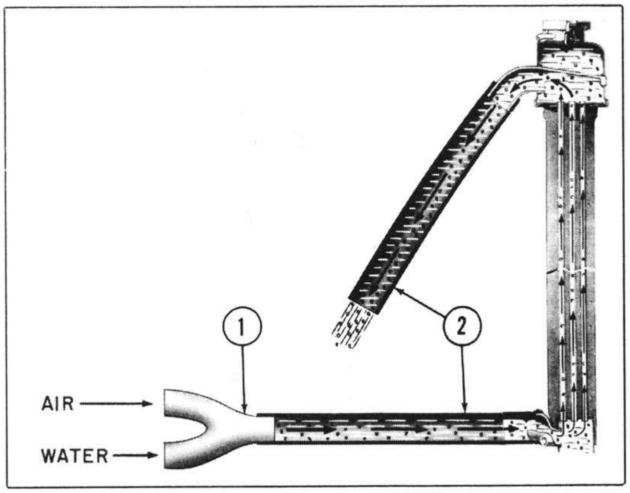

Fig. 3 Reverse Flushing the Radiator
1. Flushing Gun Nozzle 2. Hose

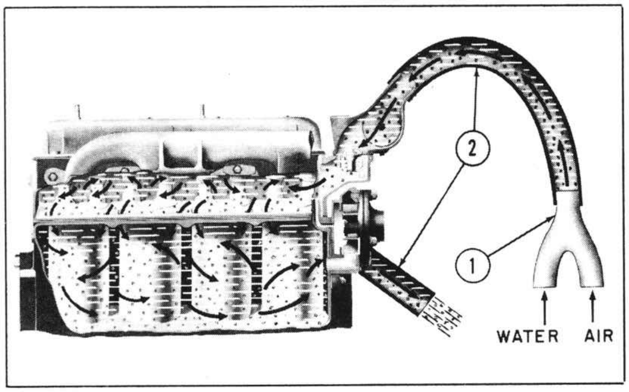

Fig. 4 Reverse Flushing the Water Jacket
1. Flushing Gun Nozzle 2. Hose

REVERSE FLUSHING THE ENGINE WATER JACKET

1. Remove the thermostat from the housing.

2. Connect the flushing nozzle into the upper hose. See Fig. 4.

3. Hold your hand over the lower opening of the water jacket, fill the water jacket and gradually apply air.

4. Follow the same general procedure for flushing the water jacket as the one outlined for flushing the radiator. Continue flushing until the discharge stream of water from the lower water jacket opening is clean.

NOTE: Follow the manufacturers recommendations when using a radiator cleaner or flushing compound.

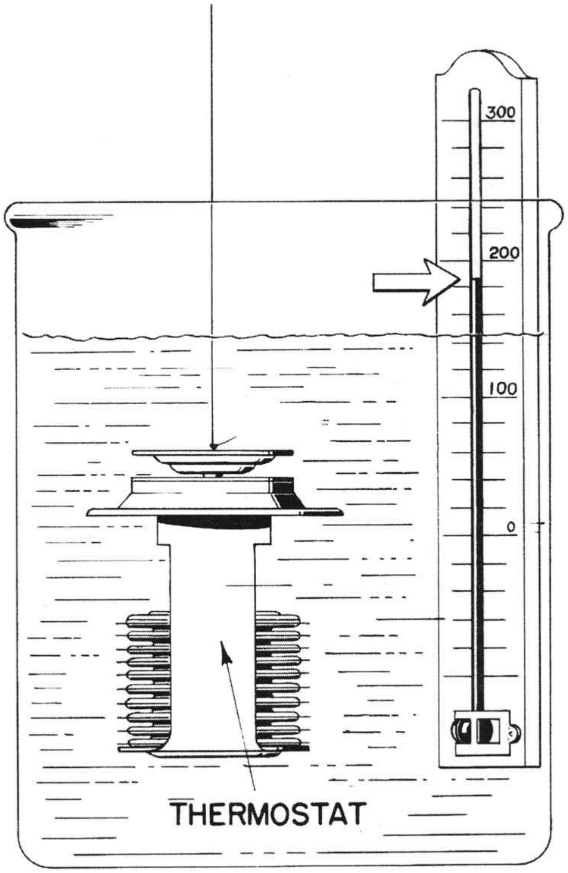

Fig. 5 Checking the Thermostat

CHECKING THE THERMOSTAT

The life of the engine will be shortened considerably if the engine is operated at a temperature other than that specified. To maintain specified operating temperatures, it is imperative the thermostat is operating properly. The thermostatic operation can be checked in the following manner.

1. Hang the thermostat by its frame in a container of water so that it does not touch the bottom, See Fig. 5.

2. Heat the water and check the temperature with a thermometer. Stir frequently so that the heat is distributed evenly.

3. If the valve does not start to open at the proper temperature (plus or minus 5^{o} of the temperature stamped on the thermostat), or if it opens before the proper temperature is reached, the thermostat should be replaced.

PART 1. SPECIFICATIONS

MODEL 4-A-203 ENGINE

Number of Cylinders	4
Firing Order	1-3-4-2
Valve Arrangement	Overhead
Bore	3.6 Inches
Stroke	5 Inches
Piston Displacement	203.5 Cubic Inches
Compression Ratio	17.4 to 1
*Compression Pressure (with cranking speed of 200 - 250 RPM)	440 - 460 P.S.I.
Low Idle Speed	500 - 550 (PTO speed of 180 - 198 RPM)
Rated Engine Speed	2,000 - 2,050 RPM
High Idle Speed (No Load)	2100 - 2150 RPM (PTO speed 756 - 774 RPM)

*Engine at operating temperature, all injectors removed, and fuel control in shut-off position. Minimum compression pressure approximately 390 P.S.I.

Pistons

Piston Diameter (Measured at right angles from piston pin)

Top Piston Skirt Diameter	3.5936 - 3.5946 Inches
Bottom Piston Skirt Diameter	3.5955 - 3.5965 Inches
Piston Pin Bore Diameter	1.2495 - 1.250 Inches

Sleeves

Inside Diameter of Sleeve	3.6015 - 3.6025 Inches
Outside Diameter of Sleeve	3.6875 - 3.6885 Inches
Cylinder Block Bore	3.6875 - 3.6885 Inches
Location of Sleeve Flange Below Top Face of Block	0.001 - 0.009 Inch

Piston Pins

Pin Diameter	1.24975 - 1.250 Inches
Clearance in Connecting Rod Bushing	0.0005 - 0.00175 Inch
Clearance in Piston Pin Bore	Minus 0.0005 - Plus 0.00025 Inch

Piston Rings

RING SIDE CLEARANCE

New Compression Rings (Plain and Taper Faced)	0.0019 - 0.0039 Inch
New Oil Rings	0.002 - 0.004 Inch

RING GAP CLEARANCE

Compression Rings (Plain and Taper Faced)	0.009 - 0.013 Inch
Oil Rings	0.009 - 0.013 Inch

(Ring Gap Clearance Measured in a 3.60 Inch Bore)

Connecting Rods

Connecting Rod Bore Diameter (Bushing End)	1.37475 - 1.3762 Inches
Inside Bushing Diameter (Finished)	1.2505 - 1.2515 Inches
Connecting Rod Bore Diameter (Bearing End)	2.3950 - 2.3955 Inches
Bearing Clearance	0.00175 - 0.00325 Inch
Rod Side Play	0.0095 - 0.0133 Inch

Crankshaft And Main Bearings

Crankpin Journal Diameter	2.2485 - 2.249 Inches
Main Bearing Journal Diameter	2.7485 - 2.749 Inches
Block Bore Diameter (Main Bearings)	2.9165 - 2.9175 Inch
Main Bearing Clearance	0.0027 - 0.0045 Inch
Crankshaft End Play	0.002 - 0.010 Inch

Valves

Valve Head Diameter	
Intake	1.532 - 1.536 Inches
Exhaust	1.313 - 1.317 Inches
Stem Diameter (Intake and Exhaust)	0.311 - 0.312 Inch
Stem Clearance Limits (Intake and Exhaust)	0.002 - 0.0045 Inch
Face Angle (Intake and Exhaust)	44 Degrees
Valve Interference Angle (Intake & Exhaust)	1 Degree (Valve Face 44 Degrees and Valve Seat 45 Degrees)
Minimum Margin (Intake and Exhaust)	1/32 Inch
Valve Lash (Intake and Exhaust)	0.010 Inch (Hot), 0.012 Inch (Cold)
Valve Head Clearance Below Face of Cylinder Head	
Clearance Limits (Intake and Exhaust)	0.070 - 0.140 Inch Below Face

Valve Seats (Intake and Exhaust)

Seat Angle	45 Degrees
Seat Contact Width	1/16 Inch
Maximum Seat Runout	0.002 Inch

Valve Guides (Intake and Exhaust)

Inside Diameter (Shouldered and Shoulderless Type)	0.314 - 0.3155 Inch
Clearance Limits (Stem-to-Guide)	0.002 - 0.0045 Inch
Guide Height Above Valve Spring Seat	
Shouldered Type	Correct Height when Shoulder Contacts Top Face of Cylinder Head
Shoulderless Type	0.584 - 0.594 Inch

Valve Springs (Intake and Exhaust)

Inner Spring	
Approximate Free Length	1-3/8 Inches
Spring Length Valve Closed	1-3/16 Inches
Spring Pressure @ 1-3/16 Inch Length	7 - 9 lbs.
Spring Length Valve Open	27/32 Inch
Spring Pressure @ 27/32 Inch Length	21 - 25 lbs.
Outer Spring	
Approximate Free Length	1-25/32 Inches
Spring Length Valve Closed	1-1/2 Inches
Spring Pressure @ 1-1/2 Inch Length	21 - 25 lbs.
Spring Length Valve Open	1-5/32 Inches
Spring Pressure @ 1-5/32 Inch Length	48 - 52 lbs.

Valve Tappets

Tappet Stem Diameter	0.6225 - 0.62375 Inch
Tappet Bore in Cylinder Head	0.6245 - 0.62575 Inch
Clearance Limits	0.00075 - 0.0035 Inch

Rocker Arm Shaft Assembly

Rocker Arm Shaft Diameter	0.62225 - 0.62375 Inch
Inside Bushing Diameter (Rocker Arm)	0.6245 - 0.62575 Inch
Clearance Limits (Shaft-to-Bushing)	0.00075 - 0.0035 Inch

Valve Timing (Crankshaft Degrees)

Intake Valve Opens	13 Degrees B.T.D.C.
Intake Valve Closes	43 Degrees A.B.D.C.
Exhaust Valve Opens	46 Degrees B.B.D.C.
Exhaust Valve Closes	10 Degrees A.T.D.C.

Timing Gears

Timing Gear Backlash (All Except Oil Pump)	0.003 - 0.006 Inch
Idler Gears and Hubs	
Hub Diameters (Upper and Lower)	1.996 - 1.997 Inches
Upper Idler Gear Bore	1.9998 - 2.0007 Inches
Inside Bushing Diameter (Lower Idler Gear)	1.9998 - 2.0007 Inches
Clearance Limits - Idler Gears-to-Hubs	0.0028 - 0.0047 Inch
Idler Gear End Play (Upper and Lower)	0.002 - 0.004 Inch
Injection Pump Drive	
Spindle Diameter (Injection Pump Support)	1.6225 - 1.6238 Inches
Hub Bore Diameter	1.6245 - 1.626 Inches
Clearance Limits - Spindle-to-Hub	0.0007 - 0.0035 Inch
Hub End Play	0.0011 - 0.003 Inch

Camshaft

Front Bearing Journal Diameter	1.869 - 1.870 Inches
Front Bearing Bore Diameter	1.874 - 1.877 Inches
Center Bearing Journal Diameter	1.859 - 1.860 Inches
Center Bearing Bore Diameter	1.864 - 1.867 Inches
Rear Bearing Journal Diameter	1.839 - 1.840 Inches
Rear Bearing Bore Diameter	1.844 - 1.847 Inches
Clearance Limits (Journal-to-Bore)	0.004 - 0.008 Inch
Cam Lift	0.3085 - 0.3165 Inch
Camshaft End Play	Controlled by a Thrust Plate in the Cylinder Block
Thrust Plate Thickness	0.125 - 0.130 Inch
Thrust Plate Location	0.008 Inch in Front to 0.003 Inch Below Face of Block

Torque Tensions

Cylinder Head	55 - 60 ft.-lbs.
Connecting Rods	70 - 80 ft.-lbs.
Main Bearings	110 - 120 ft.-lbs.
Flywheel	.75 ft.-lbs.
Intake Manifold	14 - 18 ft.-lbs.
Injector Securing Nuts	20 - 22 ft.-lbs.
Rocker Shaft Supports	21 - 24 ft.-lbs.

FUEL AND AIR SYSTEM

DIESEL FUEL OIL (American Society of Testing Materials Specifications)

LIMITING REQUIREMENTS FOR DIESEL FUEL OILS
ASTM Designation: D975-59T

Grade of Diesel Fuel Oil	Flash Point, deg. Fahr. Min.	Pour Point, deg. Fahr. Max.	Water and Sediment, percent by volume Max.	Carbon Residue on 10 percent Residuum, percent Max.	Ash, percent by weight Max.	90% Distillation Temperatures deg. Fahr.		Viscosity at 100° F. Kinematic, Centistokes (or Saybolt Universal sec.)		Sulfur, percent by Weight Max.	Copper Strip Corrosion Max.	Cetane Number Min.
						Min.	Max.	Min.	Max.			
No. 1-D Winter Operation	100 or legal	...	Trace	0.15	0.01	...	550	1.4	2.5 (34.4)	0.50	No. 3	40
No. 2-D Summer Operation	125 or legal	...	0.10	0.35	0.02	540	675	2.0 (32.6)	5.8 (45)	1.0	No. 3	40

For cold weather operation the pour point should be specified 10 F. below the ambient temperature at which the engine is to be operated.

Low-atmospheric temperatures as well as engine operation at high altitudes may require use of fuels with higher cetane ratings.

FUEL TANK

Capacity . . . . 13-3/4 U.S. or 11-1/2 Imp. Gallons

FUEL PUMP

Operating Pressure . . . . 5 - 8 PSI

INJECTION PUMP (C.A.V. DPA TYPE, NO'S. 3242656, 3242657, 3242697 & 3242698)

Injection Timing - Static . . . . 18 or 20 degrees B.T.D.C. (depending on model)

Idle Speed Adjustment

Low Idle Speed. . . . . .500 - 550 RPM (PTO speed of 180 - 198 RPM)
Rated Engine Speed. . . . . 2000 - 2050 RPM (PTO speed of 720 - 738 RPM)
High Idle Speed . . . . 2100 - 2150 RPM (PTO speed of 756 - 774 RPM)

FUEL INJECTORS (C.A.V. - NOZZLE NO. BDL 110S6133 & NOZZLE HOLDER NO. BKB 32SD5085)

Opening Pressure Setting

Used Injectors (more than 25 hrs. operation). . . . . 1760 PSI
New Injectors or old Injectors with new springs. . . . . 1980 PSI

AIR CLEANER

Capacity . . . . Fill to mark

THERMOSTAT (C.A.V.)

Solenoid Type	
Voltage	12
Nominal current consumption	15 amperes
Fuel flow rate through thermostart	10 c.c. per min.
Mark III Type	
Voltage	12
Maximum current consumption	18 amperes
Fuel flow rate through thermostart	9 c.c. per min.

TORQUE TENSIONS

Injector Securing Nuts	21 - 24 ft.-lbs.
Nozzle Cap Nut	50 ft.-lbs.
Leak-Off Banjo Bolts	5 - 7 ft.-lbs.
Injection Pump Mounting Screws	12 - 14 ft.-lbs.
Fuel Pump Securing Nuts	12 - 14 ft.-lbs.

LUBRICATION SYSTEM

TYPE OF OIL

API Service Class	DG

VISCOSITY

Above 90°F.	SAE 30
From 32°F. to 90°F.	SAE 20 or 20/20W
From 10°F. to 32°F.	SAE 10W
From -10°F. to 10°F.	SAE 5W or 5W/20

CRANKCASE CAPACITY

Without Filter Change	7 U.S. (5.8 Imperial) quarts
With installation of new filter	7.5 U.S. (6.3 Imperial) quarts

OIL CHANGE PERIOD

Change Oil at Regular Intervals	Every 100 hours

OIL PUMP

Capacity	5.75 U.S. Gallons per minute at engine speed of 2000 rpm
Idler Gear - Bore	0.750 - 0.751 inch
Idler Gear - Bushing	(Inside diameter) 0.6562 - 0.6572 inch.
Idler Shaft Diameter	0.65475 - 0.65535 inch
Idler Thrust Washer Thickness	0.062 - 0.067 inch
Idler End Play on Hub	0.001 - 0.015 inch
Drive Gear - Bore	0.4970 - 0.4978 inch
Drive Shaft Diameter	0.4980 - 0.4985 inch
Pump Gears Backlash	0.012 - 0.018 inch
Inner to Outer Rotor Clearance	0.006 inch maximum
Outer Rotor to Pump Body Clearance	0.010 inch maximum
Top of Rotors to Face of Pump Body Clearance	0.003 inch maximum

OIL PRESSURE RELIEF VALVE

Relief Valve Setting	50 - 65 PSI
Relief Valve Spring	
Free Length	1-1/2 inches
Lbs. Pressure @ 1-1/4 inches	5-1/4 - 7-1/4 lbs.
Lbs. Pressure @ 1 inch	11-1/2 - 13-1/2 lbs.

OIL FILTER

Change Period	Every other oil change (200 hours)
By-Pass Valve Opens	13 - 17 PSI (Differential pressure)

ENGINE OIL PRESSURE

Operating Oil Pressure	25 - 60 PSI

COOLING SYSTEM

COOLING SYSTEM

Capacity	10 U.S. or 8 Imp. quarts

THERMOSTAT

Opening Temperature	168 - 176 Degrees F.

RADIATOR PRESSURE CAP

Releases pressure at	10 PSI.

FAN BELT

Proper tension	1/2 inch deflection

WATER PUMP

Capacity	Approximately 32 gallons per minute at 2000 engine RPM

GROUP I - SECTION C - PART 2

ENGINE OVERHAUL PROCEDURE

INDEX

	Page		Page
Engine	1	Cylinder Sleeves	16
Engine Removal	3	Timing Gear Cover and Front Crankshaft Oil Seal	17
Engine Installation	4	Crankshaft and Main Bearings	18
Rocker Arm Shaft Assembly	4	Rear Crankshaft Oil Seal	22
Cylinder Head	6	Camshaft and Timing Gears	23
Cylinder Block	12	Timing Gear Housing	30
Piston and Connecting Rod Assembly	12		

Before starting disassembly of the tractor, make a complete diagnosis of the engine to be sure that an overhaul is really necessary. If it is determined that an overhaul is necessary, then inspect the entire engine for any evidence of external leaks, or defective parts, that must also be corrected before the tractor is assembled and returned to the customer.

Where the right and left-hand sides are mentioned in this section, it refers to the tractor or engine as viewed from the rear. Direction of engine rotation, however, is viewed from the front of the engine.

ENGINE

The 4A - 203 diesel engine is a four cylinder, overhead valve type engine using dry sleeves with a bore of 3.6 inches and a stroke of 5 inches. The compression ratio is 17.4 to 1. The combustion system utilizes both direct and indirect fuel injection. Maximum engine torque is 151 ft.-lbs. occurring at an engine speed of approximately 1,350 r.p.m.

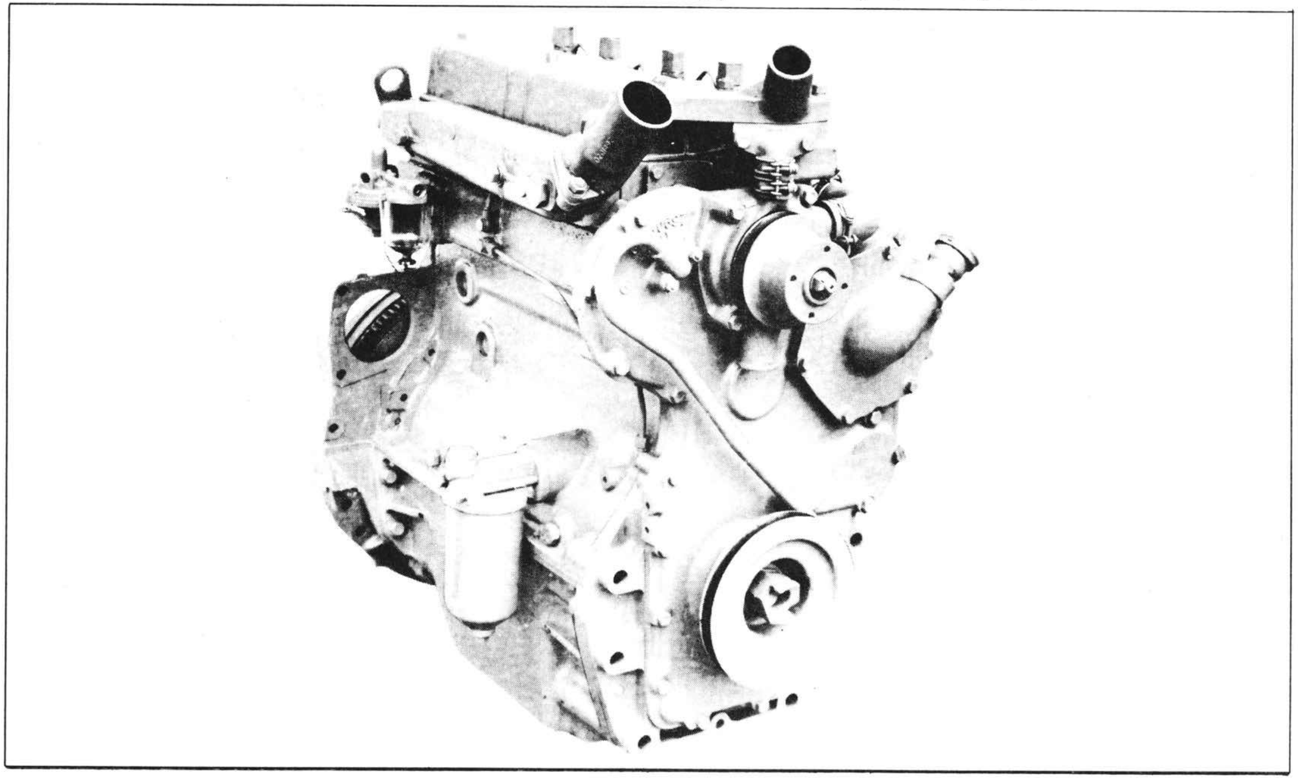

Fig. 1 - Front Right Hand View of 4A-203 Engine

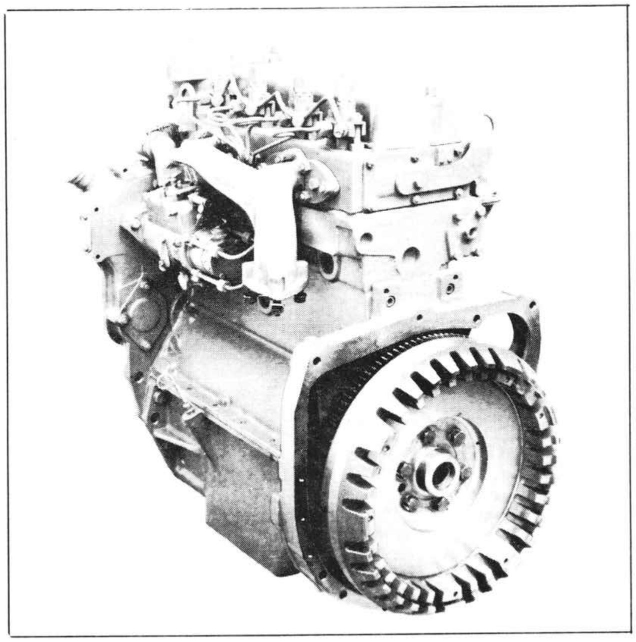

Fig. 2 - Rear Left Hand View of 4A-203 Engine

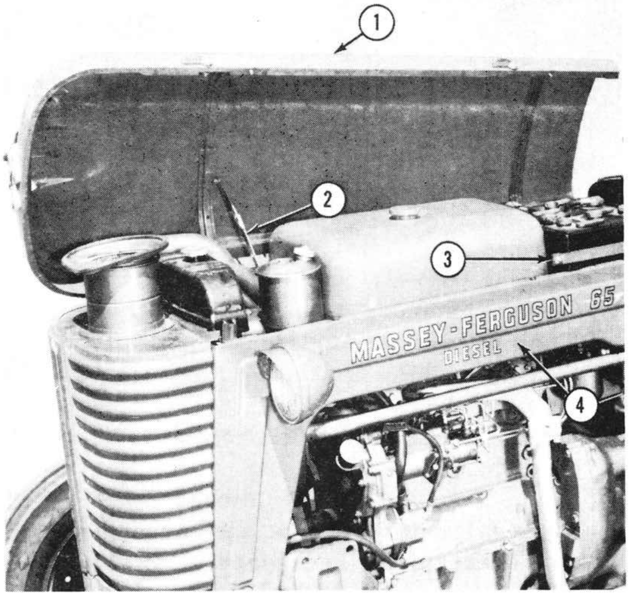

Fig. 3 - Nomenclature

1. Hood
2. Hood Stop Lever
3. Battery Strap Assembly
4. Left Hand Side Panel

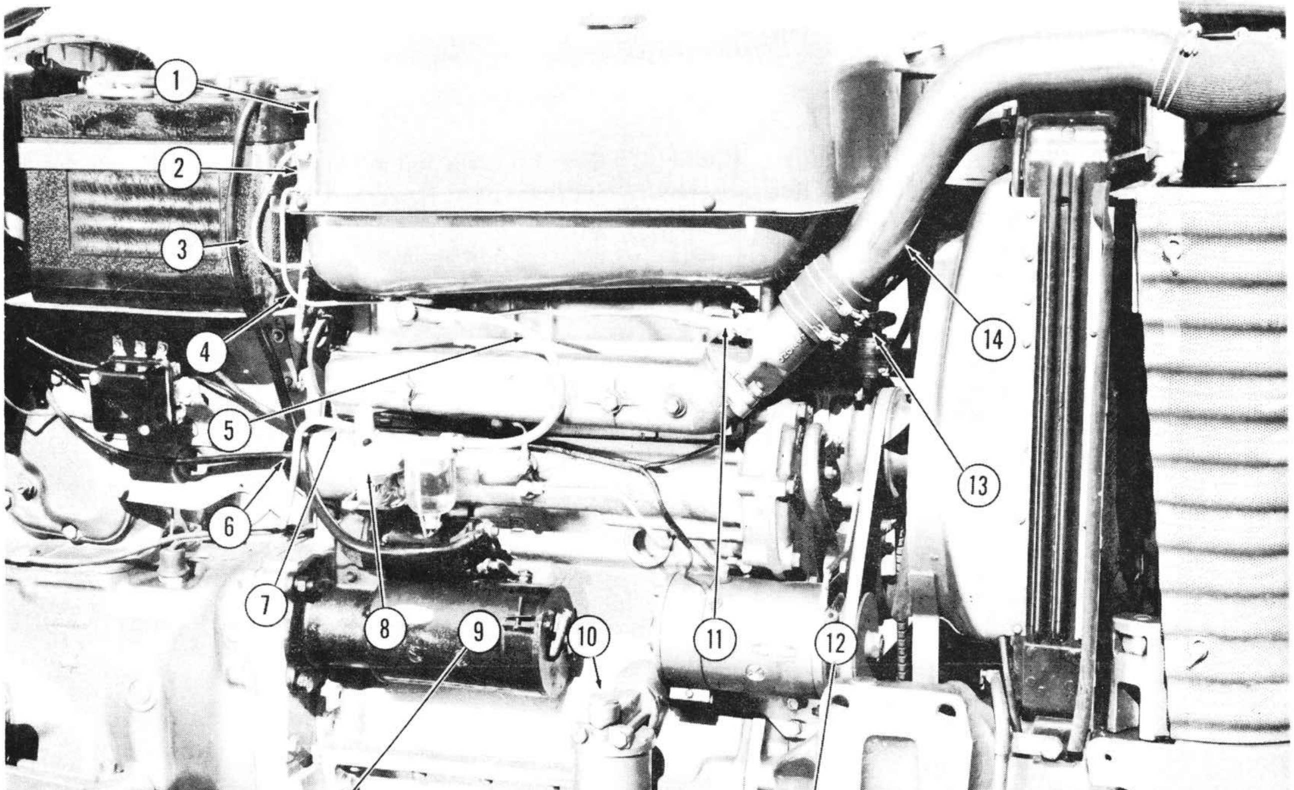

Fig. 4 - Nomenclature

1. Reserve to Fuel Tank Line
2. Reserve Tank
3. Fuel Feed-Back Line
4. Reserve Tank to Manifold Fuel Line
5. Main Fuel Shut-Off Line
6. Tractormeter Cable
7. Fuel Pump to Primary Filter
8. Fuel Pump
9. Oil Pan Adapter
10. Oil Filter
11. Intake Manifold Heater
12. Front Axle Support
13. Thermostat Body Connection (By-Pass)
14. Air Cleaner Pipe

ENGINE REMOVAL

To remove the engine and clutch follow the steps listed: Refer to Figs. 3, 4 and 5.

1. Drain cooling system, also crankcase if engine is to be disassembled.

2. Disconnect head lights if so equipped, and remove hood and side panels.

3. Remove fuel tank. To remove tank proceed as follows:

a. Disconnect and remove batteries, and battery strap assembly.

b. Shut off fuel tank and disconnect main fuel line, No. 5, Fig. 4, from tank.

c. Disconnect and remove the lower fuel line from reserve tank, No. 4, Fig. 4, to intake manifold heater.

d. Disconnect and remove the upper feedback fuel line, No. 3, Fig. 4, from reserve tank to leak-off line.

e. Disconnect the fuel line, No. 1, Fig. 4, from reserve tank to main fuel tank.

f. Remove nuts and springs from bolts securing the fuel tank and remove fuel tank from engine.

> *IMPORTANT: Cover all open fuel lines and connections to prevent dirt from entering into the system. CLEANLINESS CAN NOT BE OVEREMPHASIZED.*

4. Disconnect electrical wires from generator, intake manifold heater, No. 11, Fig. 4, and starter, and remove starter.

5. Disconnect tractormeter, No. 6, Fig. 4.

6. Disconnect and remove pipe from air-cleaner to intake manifold.

7. Remove fuel line, No. 7, Fig. 4, from fuel pump to primary fuel filter, No. 12, Fig. 5.

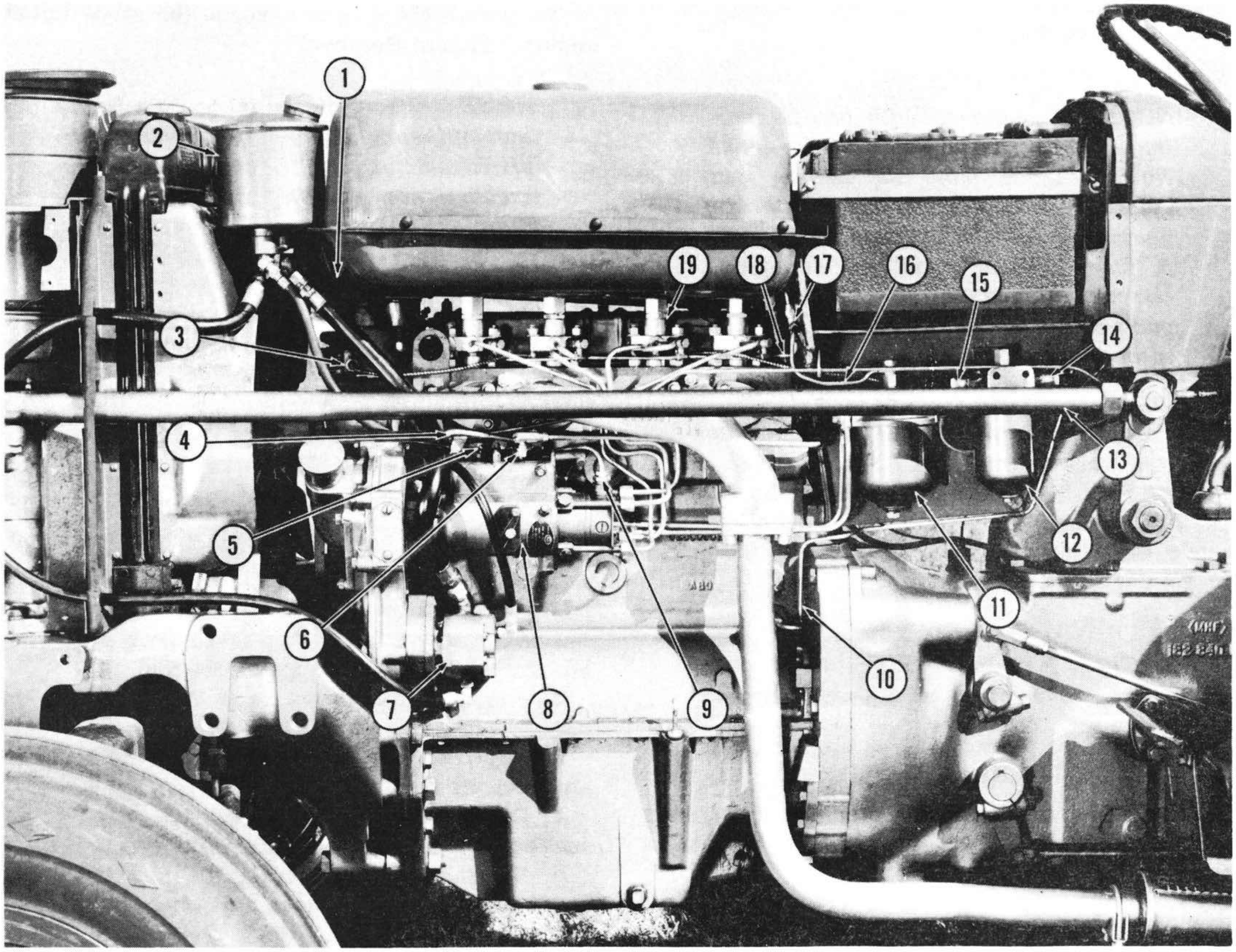

Fig. 5 - Nomenclature

1. Power Steering Reservoir Support
2. Power Steering Reservoir
3. Heat Indicator Wire
4. Injection Pump to Secondary Filter Fuel Line
5. Fuel Shut-Off Rod
6. Injection Pump Control Rod
7. Power Steering Pump
8. Fuel Injection Pump
9. Secondary Filter to Injection Pump Fuel Line
10. Oil Pressure Gauge Line
11. Secondary Fuel Filter
12. Primary Fuel Filter
13. Drag Link
14. Primary to Secondary Filter Fuel Line
15. Fuel pump to Primary Filter Fuel Line
16. Tee to Secondary Filter Fuel Line
17. Leak-Off Tee
18. Injector Leak-Off Line Assembly
19. Injection Nozzle Assembly (Injector)

8. Disconnect fuel shut-off rod, No. 5, Fig. 5, from fuel injection pump, No. 8, Fig. 5, and loosen the spring anchor clip at the rear-end of the shut-off rod and slide rod rearward.

9. Disconnect and remove injection pump control rod, No. 6, Fig. 5.

10. Disconnect and remove fuel lines from secondary fuel filter, No. 11, Fig. 5, to fuel injection pump.

11. Disconnect and remove injector leak-off return line, No. 18, Fig. 5. (From #3 or #4 injector to tee, No. 17, Fig. 5, depending on model).

12. Disconnect and remove oil pressure gauge line, No. 10, Fig. 5.

13. Disconnect heat indicator wire from thermostat housing.

14. Disconnect exhaust pipe from exhaust manifold.

15. Disconnect the drag link, No. 13, Fig. 5, from the steering arm.

NOTE: If equipped with power-steering, unbolt the power-steering pump, No. 7, Fig. 5, from the timing gear housing, also remove power-steering reservoir support bracket, No. 1, Fig. 5, from cylinder head and fan shroud. (Do not disconnect oil lines). Lay pump and reservoir in grille enclosure after they are removed.

16. Securely support the tractor under the front of the transmission housing and under rear of front axle support, No. 12, Fig. 4.

17. Disconnect the radiator hoses and remove the bolts securing the front axle support to the engine.

NOTE: Remove generator to gain access to upper right-hand support bolt.

18. With front end supported securely, roll the front end unit away from engine as shown in Fig. 6.

19. Attach chain to the engine lift bracket and support engine in a hoist. Remove all the nuts and bolts securing the engine to the transmission housing and battery platform and remove the engine.

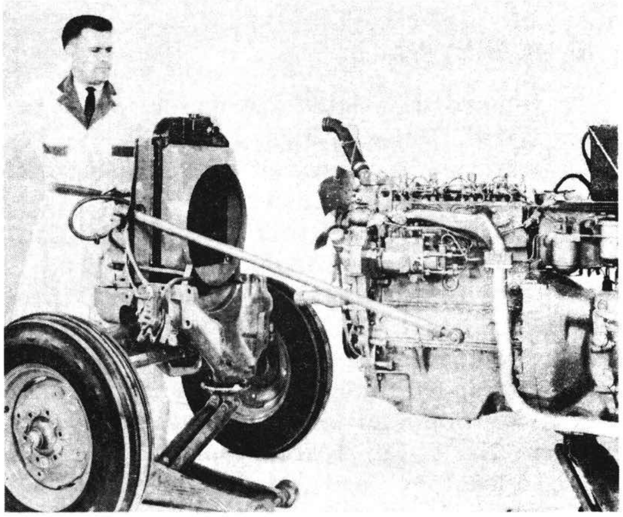

Fig. 6 - Removing Front End From MF 65 Tractor

ENGINE INSTALLATION

To install the engine reverse the steps listed under "Engine Removal".

NOTE: When joining the engine to the transmission housing, turn the crankshaft and/or P.T.O. to line up the transmission shafts with the clutch plate splines.

CYLINDER HEAD ASSEMBLY

The cylinder head assembly consists of the head complete with the valves, tappets and rocker arm shaft assembly.

Rocker Arm Shaft Assembly

REMOVAL

To remove the rocker arm shaft assembly proceed as follows: Refer to Fig. 7.

1. Disconnect hood stop lever from fuel tank and support hood in an open position.

2. Remove fuel tank, see step No. 3, on page 2.

3. Remove nuts securing rocker arm cover and remove cover.

4. Disconnect oil line, No. 3, Fig. 7, to rocker arm shaft at cylinder head end.

5. Work from the center to both ends and gradually loosen the nuts securing the rocker shaft supports, No. 4, Fig. 7.

6. After loosening, remove nuts and lift rocker arm shaft assembly from cylinder head.

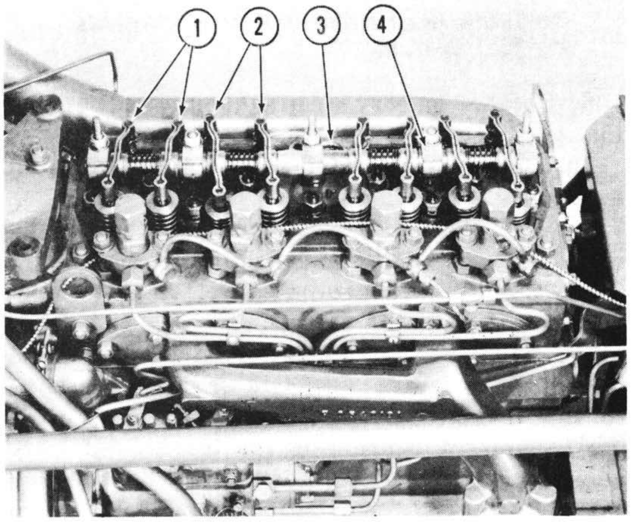

Fig. 7 - Rocker Arm Shaft Assembly

1. Right Hand Rocker Arms
2. Left Hand Rocker Arms
3. Rocker Shaft Oil Line
4. Rocker Shaft Support

DISASSEMBLY

Before disassembling the rocker arm shaft assembly, observe that the rocker arms are right and left-hand assemblies and can not be interchanged, refer to No's. 1 and 2, Fig. 7. Observe that the slot, No. 3, Fig. 8, in the rear-end of the rocker shaft is in line with the punch mark, No. 2, Fig. 8, on the rear support bracket. The amount of oil circulating to the rocker assembly can be adjusted by positioning this slot. The punch mark on the support bracket (stamped 30 degrees from vertical position) shows where the slot is normally set.

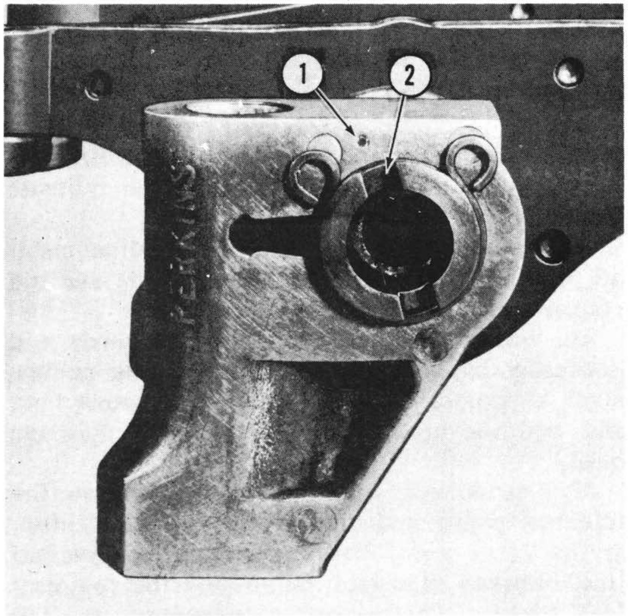

Fig. 8 - Rear Support Marked to Show Correct Position of Slot

1. Punch Mark on Rear Support Bracket 2. Rocker Shaft Slot Correctly Positioned

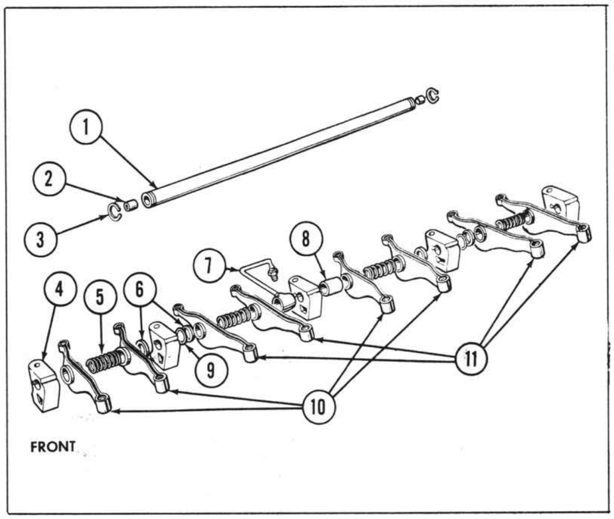

Fig. 9 - Nomenclature

1. Rocker Shaft
2. Rocker Shaft Plug
3. Snap Ring
4. Rocker Shaft Support Bracket
5. Rocker Shaft Spring
6. Rocker Shaft Spacers
7. Rocker Shaft Oil Line
8. Rocker Shaft Spacer
9. Rocker Shaft Shim
10. Right Hand Rocker Arms
11. Left Hand Rocker Arms

NOTE: Only in the event of inadequate, or excessive rocker arm lubrication should the slot be repositioned. Minimum oil flow occurs with the slot in the vertical position.

To disassemble proceed as follows: Refer to Fig. 9.

1. Remove the retaining snap ring from each end of the rocker shaft.
2. Remove the support brackets, rocker arms, spacer springs, spacers and rocker shaft oil line. Lay all parts in order, so they may be installed in the same sequence.
3. Remove the plugs from the rocker shaft so that the shaft may be thoroughly cleaned.

INSPECTION

Clean all parts in a suitable solvent, make sure all oil holes are open and proceed as follows:

1. Inspect the rocker arm bearing surfaces of the shaft for scoring. Replace shaft if scored.
2. Inspect for and replace any rocker arms that have seized and have loose bushings. Also discard rocker arms with worn or pitted contact surfaces.

NOTE: Rocker arms and bushings are not serviced separately and if either is worn or defective, new rocker arms are available with bushings installed and reamed to proper size.

3. Measure diameter of bearing surfaces on rocker shaft and inside diameter of rocker arm bushings. Recommended clearance between rocker arm bushings and shaft is 0.0008 - 0.0035 inch. Replace shaft and/or rocker arms if clearance exceeds 0.0035 inch.

REASSEMBLY

To assemble the rocker arm assembly proceed as follows:

1. Install all parts in their correct sequence as shown in Fig. 10. Make sure slot in rear-end of rocker shaft is matched and lined up with punch mark in rear support, also that the stud holes in the supports are toward the intake manifold side of engine. Rocker arms are right and left-hand and must be positioned as shown in Figs. 7 and 10.
2. Complete assembly by installing a new snap ring and plug at each end of the rocker shaft.

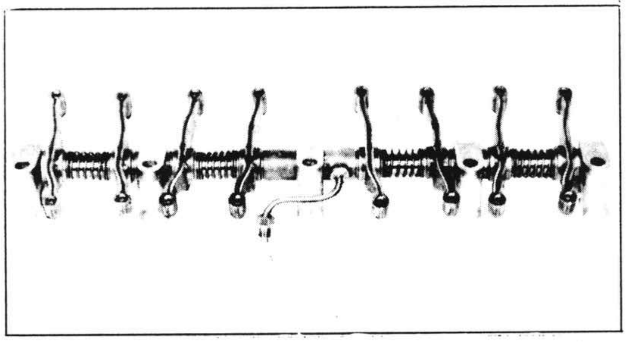

Fig. 10 - Rocker Arm Shaft Assembly Correctly Assembled

Cylinder Head

REMOVAL (ENGINE INSTALLED IN TRACTOR)

To remove the cylinder head proceed as follows:

1. Drain cooling system.
2. Disconnect the hood stop lever from the fuel tank. Disconnect head lights if so equipped and remove hood and side panels.
3. Disconnect and remove batteries.
4. Shut off fuel, then disconnect and remove main fuel line from tank to fuel pump.
5. Disconnect reservoir tank line to manifold heater, at heater.
6. Disconnect center reservoir tank line to leak-off line, at leak-off tee.
7. Disconnect reservoir tank line to main fuel tank, at main tank.
8. Remove reservoir tank with fuel lines attached to it.

IMPORTANT: Cover all fuel line openings to prevent dirt from entering the fuel system.

9. Remove battery strap assembly and remove fuel tank.
10. Disconnect electrical wire from manifold heater.
11. Disconnect air-cleaner hose at intake manifold and remove manifold from engine.
12. Remove brace between water outlet connection and radiator shroud.
13. Remove the upper radiator hose and loosen the clamps securing the by-pass hose to the thermostat body connection. Remove the capscrews connecting the thermostat body connection to the thermostat body and loosen the joint.
14. Disconnect the injector pump control rod (from the left-hand side of the cross shaft assembly) and disconnect fuel shut-off rod from the injector pump.
15. Disconnect the exhaust manifold from the exhaust pipe and remove manifold.

NOTE: Use care not to damage the fuel lines.

16. Disconnect and remove fuel lines from injector pump to the injectors.
17. Disconnect the fuel line from the leak-off line to the filter, at the tee. Then remove leak-off lines from injectors as an assembly.
18. Remove injectors.

IMPORTANT: Cover all open fuel connections to prevent dirt from entering the fuel system.

19. Disconnect and remove the oil line between the camshaft chamber and the cylinder head.
20. Remove the rocker cover and disconnect oil line between the cylinder head and the rocker shaft, at the cylinder head.
21. Work from the center to both ends and gradually loosen the nuts securing the rocker shaft supports. After loosening, remove nuts and lift rocker shaft assembly from cylinder head.
22. Disconnect the fuel lines between the injector pump and the secondary fuel filter, at the filter end. Disconnect and remove fuel line between the fuel pump and the primary fuel filter. Disconnect oil pressure line between engine block and oil pressure gauge, at engine block.

23. Unbolt the battery carrier from the transmission housing adapter plate. Remove the six forward bolts securing the steering assembly and loosen (do not remove) the two rear bolts. Then tilt the steering assembly backwards until the carrier will permit the cylinder head to be removed. Block the steering assembly rearwards and leave in this position until cylinder head is removed and reinstalled.

24. Loosen the cylinder head nuts in a REVERSE ORDER to the tightening sequence shown in Fig. 17, then remove cylinder head. Remove water outlet connection, thermostat and thermostat body from cylinder head.

INSPECTION

Disassemble the cylinder head, and thoroughly clean it and other connecting parts. Make sure all sealing surfaces are clean and not damaged. Clean all scale from the water passages in the cylinder head and inspect head for cracks. Use a straight edge and determine if cylinder head is warped. If necessary the cylinder head may be planed, however, UNDER NO CIRCUMSTANCES should its thickness be reduced below 2.980 inches. (3 inches thickness new).

> *IMPORTANT: If it is necessary to plane the head, make certain when assembling it, that the valves are within the specified distance below the face of the cylinder head.*

Examine the water jacket plugs on the cylinder head and all of the cylinder block studs for looseness, damaged or stripped threads. Replace all damaged or defective parts.

Valves

The valves are retained in the head by caps and split type cap retainers. Intake and exhaust valves are not interchangeable. Both valves are manufactured with 45 degree angle faces and have stem diameters of 0.311 - 0.312 inch. The valves, valve springs and retaining assemblies are shown in Fig. 11.

New valve specifications are as follows:

INTAKE VALVES

Face Angle.	45 degrees
Stem Diameter.	0.311 - 0.312 inch
Total Length.	4.5 inches
Head Diameter	1.532 - 1.536 inches

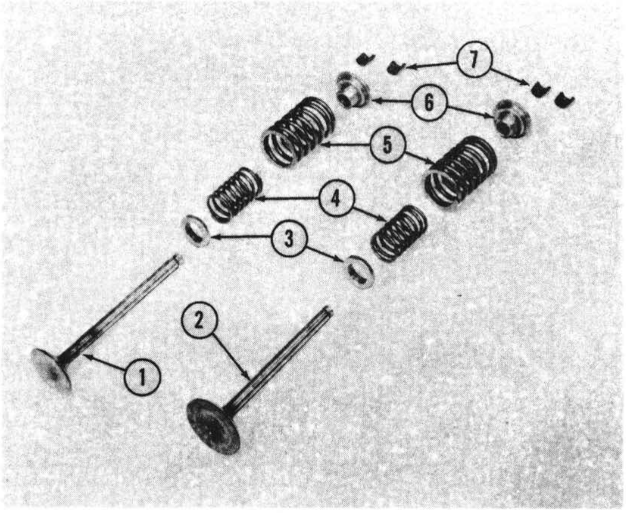

Fig. 11 - Intake and Exhaust Valve Assemblies

1. Exhaust Valve
2. Intake Valve
3. Lower Valve Spring Retainers
4. Inner Valve Springs
5. Outer Valve Spring
6. Upper Valve Spring Caps
7. Cap Retainers (Keepers)

EXHAUST VALVES

Face Angle.	45 degrees
Stem Diameter	0.311 - 0.312 inch
Total Length.	4.5 inches
Head Diameter	1.313 - 1.317 inches

REMOVAL AND INSPECTION

To remove the valves use a valve spring compressor as shown in Fig. 12. Place valves in a numbered rack so that if they are to be re-used they may be installed into their original valve guides. New valves are numbered consecutively from the front of the engine. Number replacement valves prior to installation. Thoroughly clean and inspect all valves. If valves appear to be in good condition, measure the following:

1. Thickness of valve margin -- discard valves with margins less than 1/32 inch.
2. Stem Diameter -- discard valves that have a stem diameter of 0.310 inch or less.

SERVICING

Reface new and old serviceable valves with a 44 degree face angle, (one degree interference angle used). Discard any valves that are bent or have a margin thickness of 1/32 inch or less after refacing. Replacement valves should be numbered prior to installation.

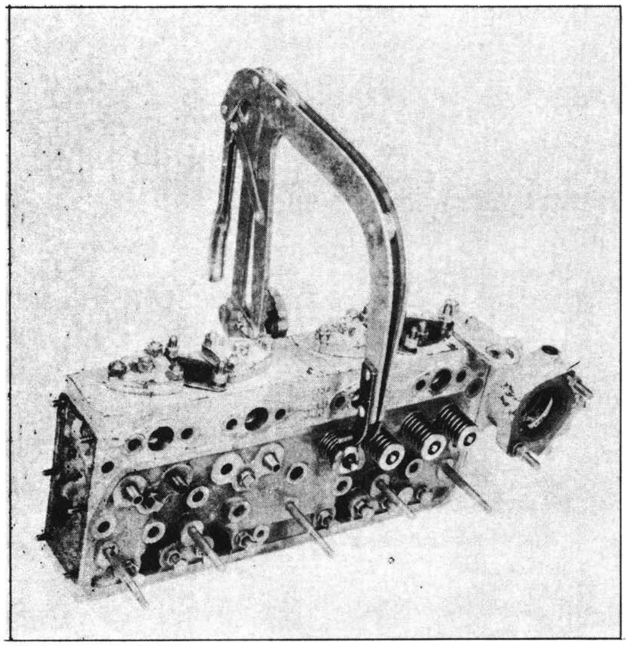

Fig. 12 - Using a Valve Spring Compressor to Remove Valves

Valve Guides

The shouldered type valve guide used in the engine is shown in Fig. 13.

Intake and exhaust valve guides are interchangeable. Inside diameter of valve guides is 0.314 - 0.3155 inch. The desired clearance between the guide and valve stem is 0.002 - 0.0045 inch for both intake and exhaust. Replacement valve guides are pre-sized and do not require reaming.

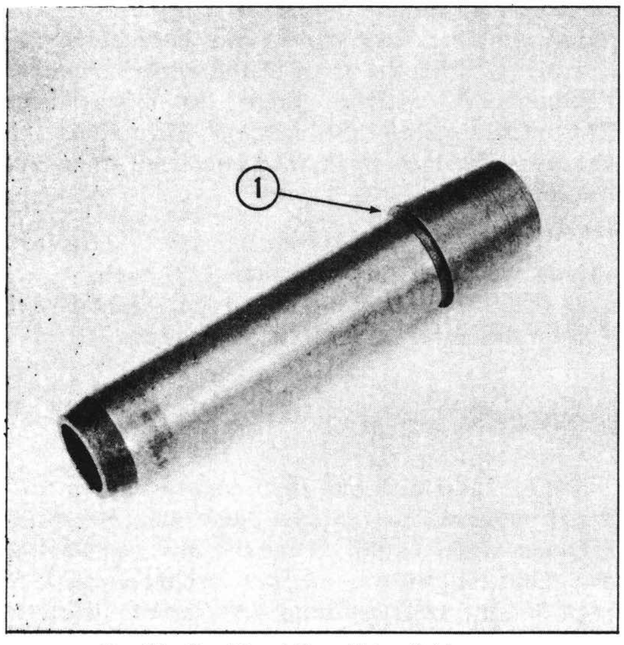

Fig. 13 - Shouldered Type Valve Guide

1. Shoulder

INSPECTION

Thoroughly clean and examine guides. Replace guides that are scored, or otherwise damaged. Measure the inside diameter of the valve guides and replace guides if diameter is more than 0.3155 inch, or if valve guide-to-stem clearance exceeds 0.0045 inch.

REPLACEMENT

Worn valve guides may be removed by pressing them out the TOP of the cylinder head. To install new valve guides use a piloted drift 0.002 inch smaller than the inside diameter of the guides and PRESS (do not drive) them into position from the TOP of the cylinder head. The guides are correctly positioned when the shoulder of the guide SEATS against the top of the cylinder head. Make sure that the shoulder is FULLY SEATED against the head. Also, when new valve guides are installed, reface the valve seats to insure concentricity of the seat to the guide.

NOTE: New shoulderless type valve guides, as shown in Fig. 14, are available and have been installed in engines with the following serial numbers;

2813333 - 2813475
2814187 and up.

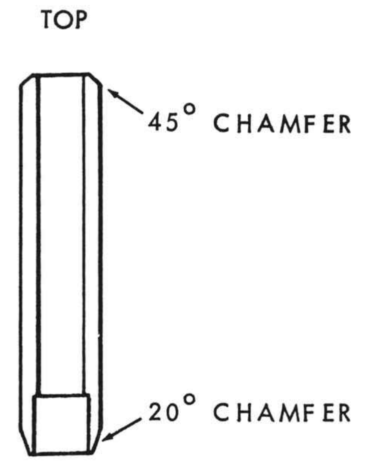

Fig. 14 - New Shoulderless Type Valve Guide

The shoulderless guide (Part No. 732 445 M1) is fully interchangeable with the shouldered type, but must ALWAYS be accompanied by the new lower valve spring retainer (Part No. 731 959 M1) in place of the previous retainer (Part No. 731 333 M1) as used with the shouldered type guides.

When installing the shoulderless guides, insert the 20 degrees chamferred end (both ends are chamferred, but with different angles) from the TOP of the cylinder head. Press the valve guide into the head until the top end (45 degrees chamferred end) extends 0.584 - 0.594 inch above the TOP face of the head.

Valve Seats

Both the intake and exhaust valves seat directly in the cylinder head, with no seat inserts being used.

INSPECTION

Thoroughly inspect each valve seat for pitting, burning or other evidence of leakage. If any of these conditions exist or if new valve guides have been installed, the valve seats must be refaced.

SERVICING

Reface intake and exhaust valve seats to a 45 degree angle, (one degree interference angle used). Remove ONLY enough metal to clean up and true the face.

IMPORTANT: The head of the intake and exhaust valves when installed in the cylinder head, must be between 0.066 - 0.140 inch below the cylinder head face. DO NOT reface the valve seat or valve to the point that the valve depth exceeds the amount specified.

After refacing the valve seats, use 20 and 70 degree stones to narrow the seat contact area to 1/16 inch. Install valve and check with prussian blue for width and location of contact area. Contact area must be in the middle of the valve face.

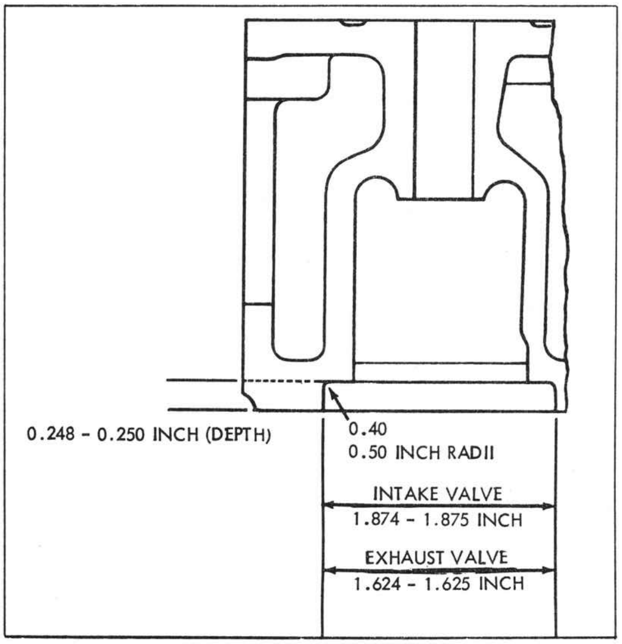

Fig. 15 - Machining Dimensions for Valve Seat Inserts

INSTALLING VALVE SEAT INSERTS

Valve seat inserts are not installed in production engines. It is possible in most cases, however, to install inserts to service engines if the existing valve seat is worn or damaged to the point where refacing would place the relationship of the valve head to the cylinder head face beyond the service limits of 0.066 - 0.140 inch. This dimension applies to both the intake and exhaust valves.

To install valve seat inserts proceed as follows:

1. Remove old valve guide and thoroughly clean valve guide bore in cylinder head.
2. Press new valve guide into position.
3. Install a pilot into the new valve guide and machine the recess in the cylinder head face to the dimensions shown in Fig. 15.
4. Remove ALL cuttings and thoroughly clean the insert recess, make sure that ALL burrs are removed and that the recess is completely clean.
5. Shrink the insert by packing it in dry ice.
6. Select the correct sized driver extensions (slightly smaller than the diameter of the recess) and using a pilot and driver PRESS THE INSERT INTO POSITION. Do not use lubricant.
7. Make sure that the insert has been pressed in squarely and that it completely contacts the bottom of the recess.
8. Reface the valve seat insert as in normal procedure.

> NOTE: *A valve head depth of 0.140 inch is outside the engine production limits, but it represents the maximum permitted depth on service engines. When refacing the insert work as close as possible to the minimum figure of 0.066 inch in order to permit further refacing during subsequent overhauls.*

Valve Springs

The valve springs, caps and split type retainers are interchangeable for the intake and exhaust valves. Two valve springs are used for each valve. Neither one of the springs have damper coils and may be installed with either end up.

INSPECTION

Discard any valve springs that do not have square ends, also those that are discolored, damaged or otherwise defective. If springs appear to be in good condition, check in a spring tester and compare readings with the following specifications:

OUTER SPRING

Approximate free length . . 1-25/32 inches
Spring length valve closed. . .1-1/2 inches
Spring pressure at 1-1/2 inch length . . 21 - 25 lbs.
Spring length valve open . . .1-5/32 inches
Spring pressure at 1-5/32 inch length . . 48 - 52 lbs.

INNER SPRING

Approximate free length . . . .1-3/8 inches
Spring length valve closed. .1-3/16 inches
Spring pressure at 1-3/16 inches . 7-9 lbs.
Spring length valve open . . . . .27/32 inch
Spring pressure at 27/32 inch. 21-25 lbs.

Tappets

The tappets are mushroom type and operate directly in the cylinder head. Fig. 16 shows a tappet removed from the cylinder head.

REMOVAL

To remove the tappets proceed as follows:

1. Remove the cylinder head.

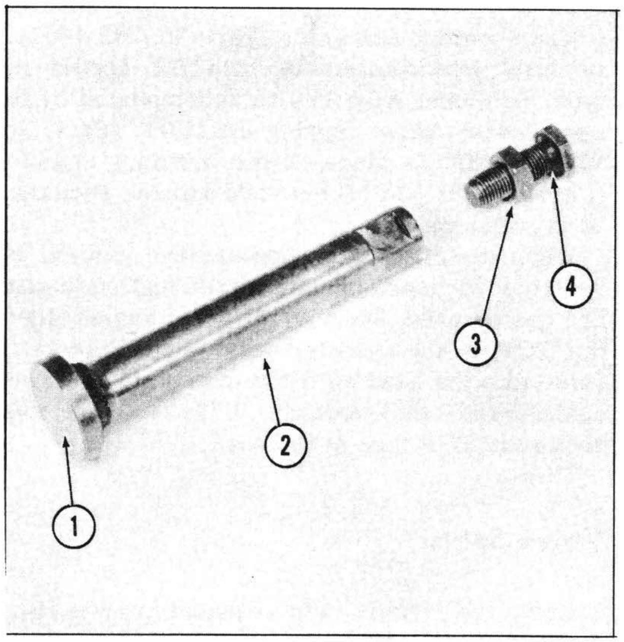

Fig. 16 - Tappet with Adjusting Screw and Lock Nut

1. Tappet Face
2. Tappet
3. Lock Nut
4. Adjusting Screw

2. Remove tappet adjusting screw and locknut.
3. Remove tappets and number them so that they may be installed into their original bores.

INSPECTION

Throughly clean the tappets and inspect them as follows:

1. Make sure tappets are free to rotate and they will slide into their bores under their own weight.
2. Inspect the tappet face. If the face of the tappet is worn or damaged, the tappet must be replaced.

> NOTE: *Do not re-grind the face of the tappet.*

3. Measure the tappet bore and the tappet stem diameter. Clearance between bore and stem must be between 0.00075 - 0.0035 inch. Install new tappets if clearance exceeds 0.0035 inch.

Combustion Chamber Caps

Whenever the engine is torn down for a major overhaul, the combustion chamber caps should be removed and the throat passages and caps cleaned. When installing the caps always use new copper gaskets, then tighten nuts evenly until they are securely tightened.

Cylinder Head Reassembly

Make sure all parts are throughly clean and serviceable, then proceed as follows:

1. Lubricate the valve stems and guides with engine oil.
2. Using a valve spring compressor, install the valves into their proper guides. Refer to Fig. 11, for proper sequence of parts.
3. Replace combustion chamber caps if they have been removed. Use new copper gaskets.
4. Replace thermostat body and water outlet connection if they have been removed. Use new gaskets and a suitable sealing compound.

Cylinder Head Installation

1. Make sure the mating surfaces of the cylinder block and head are clean then lightly coat both sides of the cylinder head gasket with oil.
2. Note that the head gasket is marked "Top Front" and install it onto the block in this position.
3. Install the cylinder head and tighten the cylinder head nuts in the sequence shown in Fig. 17, to 55-60 ft.-lbs. torque.

NOTE: Install a washer under the nut on the center cylinder head stud, No. 1, Fig. 17. This stud is shouldered and is used to prevent the installation of another head gasket which is similar and could be accidentally installed.

4. Install the rocker arm assembly and connect oil line between rocker shaft and cylinder head. Make sure that the slot in the rocker shaft is to the rear of the engine and that it is in line with the punch mark on the rear support.
5. Set valve clearance to 0.012 inch "cold".
6. Connect oil line between cylinder head and block.
7. Install injectors USING NEW WASHERS and tighten nuts to 20-22 ft.-lbs. torque. Make sure to install only one washer with each injector.
8. Connect the thermostat body connection to the thermostat body, using a new gasket and a suitable sealing compound.
9. Install the rocker cover using a new gasket.

Complete reassembly by reversing the steps listed under cylinder head "Removal". Make sure to use new gaskets when assembling the engine and DO NOT BEND FUEL LINES.

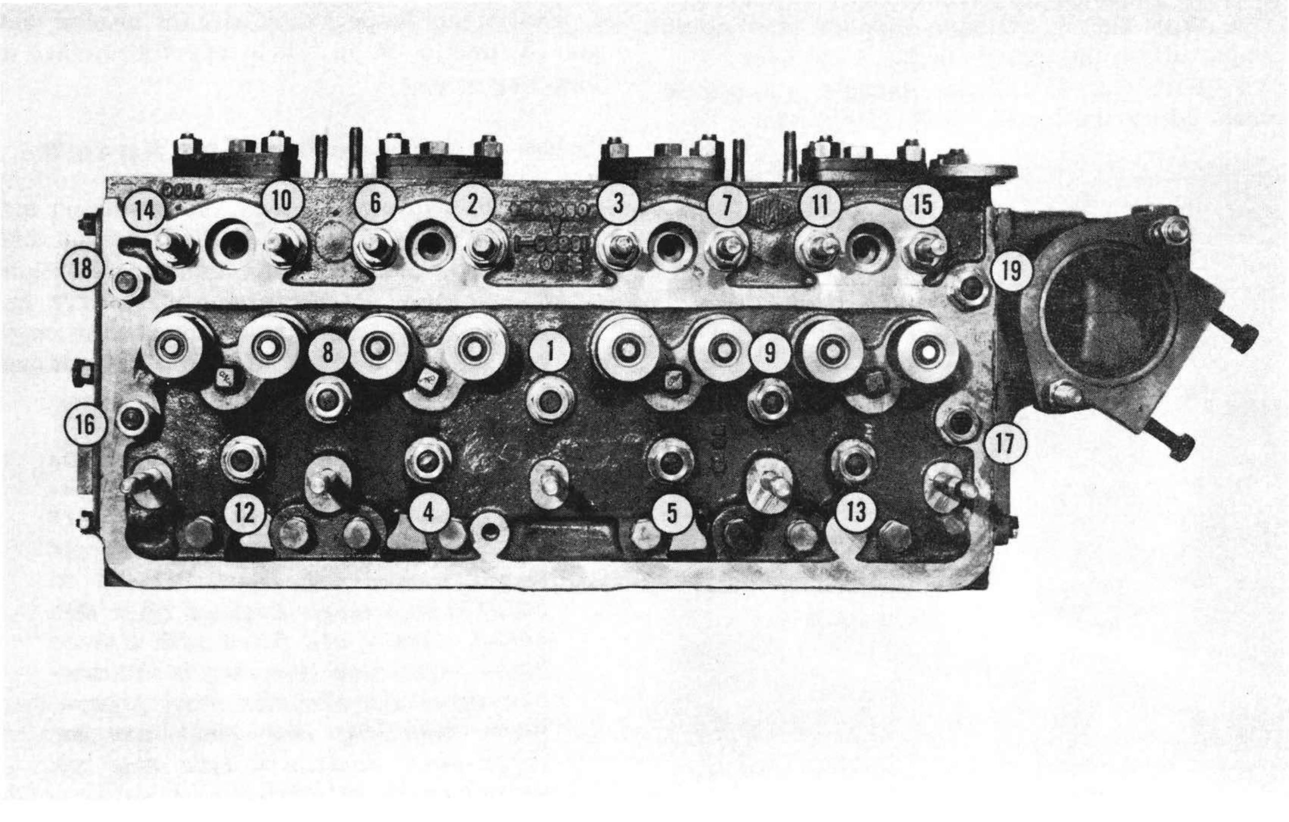

Fig. 17 - Cylinder Head Tightening Sequence

NOTE: After all parts and sheet metal have been installed, turn the fuel on and bleed the fuel system before attempting to start the engine.

Adjusting Valve Clearance

Both the intake and exhaust valve clearances should be set at 0.010 inch "hot", or at 0.012 inch "cold". To adjust the clearance "cold", proceed as follows:

1. Remove fuel tank and rocker cover.
2. Remove the plug from the inspection hole in the left front side of the transmission housing adapter plate.
3. Turn the engine until the T.D.C. mark on the flywheel is positioned in the middle of the inspection hole and the tappets of No. 4 cylinder start to rock, this indicates No. 1 piston is at T.D.C. compression stroke with both valves closed. Engine firing order is 1 - 3 - 4 - 2.
4. Adjust the valve clearance of both valves on No. 1 cylinder as shown in Fig. 18.
5. Turn the engine to the next compression stroke and with No. 2 cylinder tappets starting to rock, adjust the tappets of No. 3 cylinder.
6. With No. 1 cylinder tappets starting to rock, adjust the tappets of No. 4 cylinder.
7. With No. 3 cylinder tappets starting to rock, adjust the tappets of No. 2 cylinder.

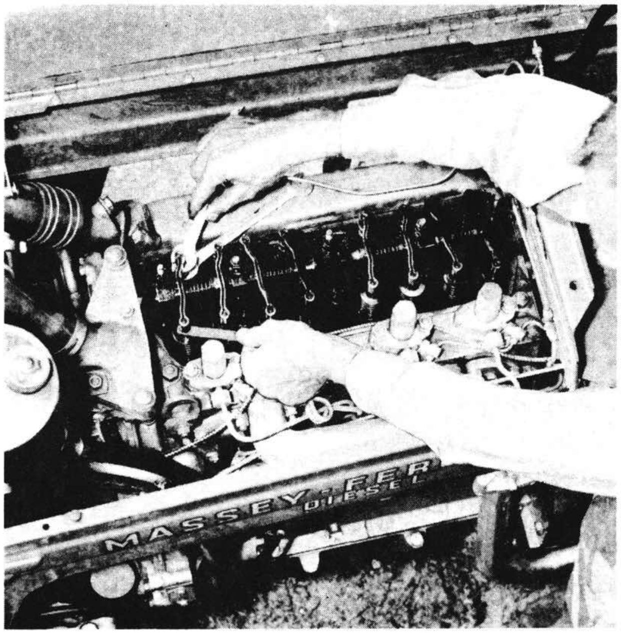

Fig. 18 - Adjusting Valve Clearance

CYLINDER BLOCK ASSEMBLY

The cylinder block assembly as referred to herein consists of the engine (removed from the tractor) without the cylinder head, oil pan, generator, water pump and other exterior assemblies.

Cylinder Block

The cylinder block is a one piece casting made of heavy duty cast iron alloy. The block is properly machined to accept the chrome plated dry type cylinder sleeves.

INSPECTION

After the cylinder block has been stripped of all removeable parts, the entire casting including the oil and coolant passages must be thoroughly cleaned and the block inspected as follows:

1. Inspect for and replace expansion plugs showing signs of leakage.
2. Inspect for and replace studs that are stripped or otherwise damaged.
3. Use a straight edge and a feeler gauge and inspect the face of the block for warping. If the block is warped it must be replaced.
4. Thoroughly inspect the block for cracks, see part 5, section A in this group for method of detecting cracks.

Piston and Connecting Rod Assembly

Fig. 19 shows the parts of the piston and connecting rod assembly. The pistons are cam ground, and are made of a special light aluminum alloy. Five piston rings are installed to each piston; three compression rings and one oil ring above the piston pin and one oil ring below the pin.

NOTE: The number three compression rings (third one down from top of piston) in engines up to serial No. 2812813 were all one piece type rings (except engines numbered from 2812689 to 2812753 inclusive). Engines after this serial number are fitted with a three piece segmented type ring in the number three compression ring groove. When installing new rings use the three piece laminated type ring for more positive oil control.

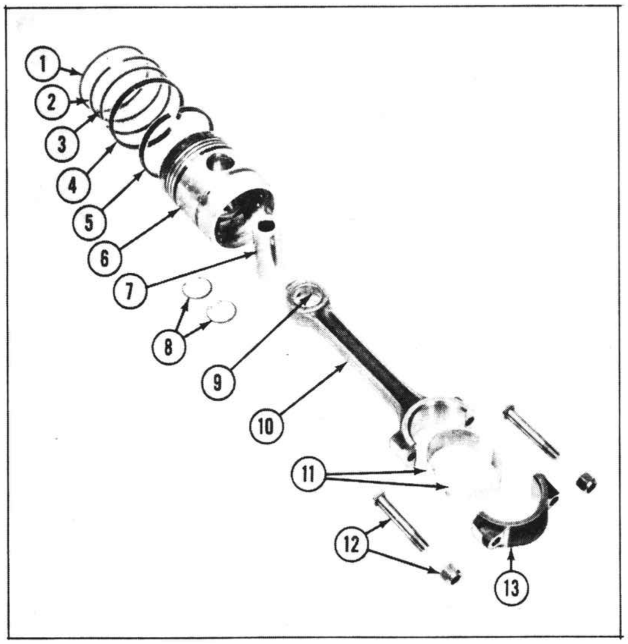

Fig. 19 - Piston and Connecting Rod Assembly Nomenclature

1. Top Compression Ring
2. No. 2 Compression Ring
3. No. 3 Compression Ring
4. No. 4 Ring (Oil Control)
5. No. 5 Ring (Oil Control)
6. Piston
7. Piston Pin
8. Piston Pin Retainers
9. Connecting Rod Bushing
10. Connecting Rod
11. Connecting Rod Bearing Inserts
12. Connecting Rod Bolt and Self Locking Nut
13. Connecting Rod Cap

The pistons are numbered from the front of the engine as shown in Fig. 20.

The connecting rods are fitted with replaceable piston pin bushings. The crank end of the rods are fitted with interchangeable precision type bearing inserts. Replacement bearing inserts are available in standard size and 0.010 inch, 0.020 inch and 0.030 inch undersize. The connecting rods and bearing caps are numbered from the front of the engine as shown in No. 2, Fig. 21, with the numbers opposite the camshaft side of the engine. Connecting rods are graded for weight and are also numbered as shown in No. 1, Fig. 21, to indicate their weight. The rod numbers and their respective weights are as follows:

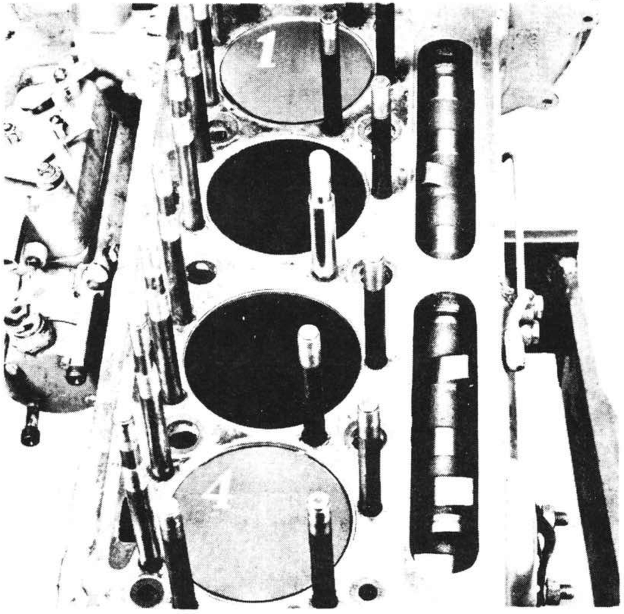

Fig. 20 · Pistons Numbered From Front of Engine

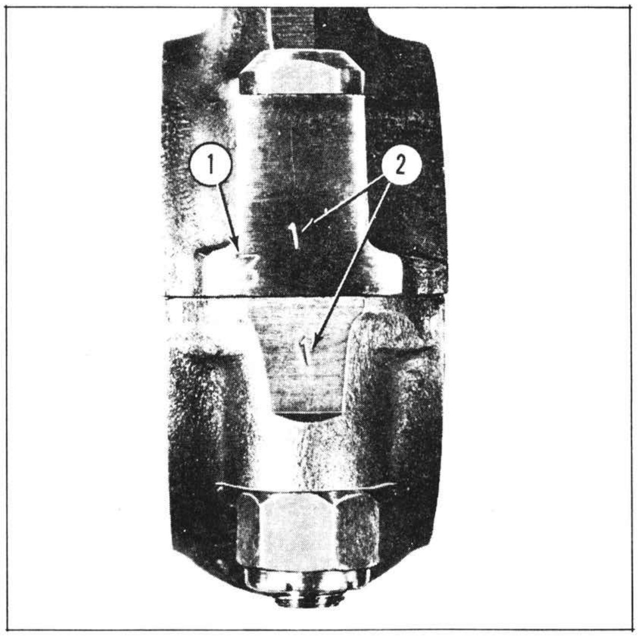

Fig. 21 - Connecting Rods Numbered and Graded by Weight

1. Weight Number
2. Cylinder Locating Number

Numbers	Rod Weight (includes bearing cap, piston pin, bushing, also nuts and bolts.)
No. 9 . . .	3 lbs. 2-1/4 ozs. - 3 lbs. 4-1/4 ozs.
No. 10 . . .	3 lbs. 4-1/4 ozs. - 3 lbs. 6-1/4 ozs.
No. 11 . . .	3 lbs. 6-1/4 ozs. - 3 lbs. 8-1/4 ozs.
No. 12 . . .	3 lbs. 8-1/4 ozs. - 3 lbs. 10-1/4 ozs.
No. 13 . . .	3 lbs. 10-1/4 ozs. - 3 lbs. 12-1/4 ozs.

The full floating type piston pins are retained by snap rings and are available in standard size only.

Removal

Whenever it is necessary to service the piston and connecting rod assemblies they should be removed as follows:

1. Drain oil, also coolant from radiator and cylinder block.
2. Remove hood, main fuel tank, rocker cover, rocker assembly and cylinder head.
3. Remove oil pan.

NOTE: It is necessary to remove the wedge shaped adapter at the rear of the oil pan in order to remove the pan.

4. Unscrew the self-locking nuts from the rod bearing caps and remove caps and bearing inserts.
5. Carefly remove any carbon accumulation that may be present around the top of the cylinder.

IMPORTANT: Sleeves are chrome plated. DO NOT attempt to remove ridge from top of cylinder OR to hone the cylinder.

6. Remove piston and rod assemblies from top of block.

NOTE: Identify and lay all parts out in their order of removal so that if serviceable they may be reinstalled in their original cylinders.

7. Discard worn piston rings and clean entire assembly.

Removing Piston From Connecting Rod

To separate the piston from the connecting rod, first mark the piston to indicate the front of the engine and remove the snap ring from each end of the piston pin. Heat piston in oil or water to 140 - 160 degrees F., and slip piston pin out of the piston.

PISTONS AND RINGS

Pistons

Thoroughly inspect the pistons as outlined in the general engine section. Discard pistons that are scored or otherwise damaged. If pistons appear serviceable proceed as follows:
1. Measure the bottom piston skirt diameter at a right angle to the piston pin.

NOTE: The piston is cam ground and is slightly tapered being larger at the bottom than at the top. New bottom piston skirt diameter is between 3.5955 - 3.5965 inches. Discard pistons that are collapsed or worn.

2. Install new rings and inspect for worn ring grooves. Piston ring-groove clearance specifications are as follows:

No. 1 compression ring..	0.0019 - 0.0039 inch
No. 2 compression ring..	0.0019 - 0.0039 inch
No. 3 compression ring..	0.0019 - 0.0039 inch
No. 4 oil ring	0.002 - 0.004 inch
No. 5 oil ring.......	0.002 - 0.004 inch

Discard pistons that worn ring grooves or bent lands.

3. Inspect the piston pin bores for wear. Discard pistons with bores that measure more than 1/250 inches or those that when fitted with a new piston pin require less than a light press fit at 160°F. Correct clearance between piston pin and piston pin bore is from minus 0.0005 inch to plus 0.00025 inch.

Piston Rings

NEVER INSTALL USED RINGS ONTO A USED OR NEW PISTON.

Recommended ring, end gap is 0.009 - 0.013 inch when installed in new sleeves. Using a piston ring tool the rings must be installed as follows:

No. 1 Compression Ring	Parallel faced cast iron ring and may be installed either side up.
No. 2 Compression Ring	Taper faced cast iron ring and MUST be installed with side marked "T" towards top of piston.

No. 3 Compression Ring

A. One piece ring used prior to engine serial No. 2812813 (except the following engines):

2810500 - 2810543
2810561 - 2810566
2812689 - 2812753

Taper faced cast iron and MUST be installed with side marked "T" towards top of piston.

B. Segmented ring used in the following serial No. engines:

2810500 - 2810543
2810561 - 2810566
2812689 - 2812753
2812813 and up

NOTE: The segmented type ring is interchangeable with the earlier type and may be used in the early model engines for more positive oil control.

Three piece ring must be installed as follows:

1. Fit the first segment onto the piston so that when held horizontally in the palm of the hand and radially compressed the ring ends point downward. Position this ring at the bottom of the groove with the gap over the piston pin bore.
2. Fit the second segment on top of the first so that when held compressed as described above, the ring ends point upward. Position the gap at 180 degrees to the first segment gap.
3. Fit the third segment on top of the second so that when held and compressed as described, the ring ends point upward. Position the gap directly over that of the first segment. Fig. 22 shows the segments correctly installed.

No. 4 Oil Control Ring (above piston pin). Cast iron scraper and may be installed either side up.

No. 5 Oil Control Ring (below piston pin). Cast iron scraper and may be installed either side up.

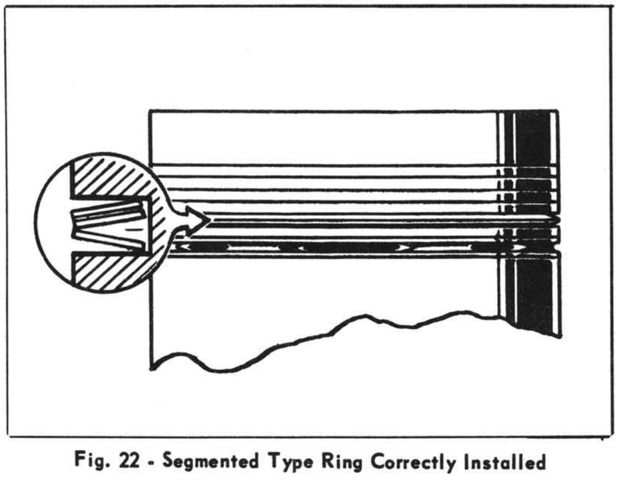

Fig. 22 - Segmented Type Ring Correctly Installed

CONNECTING RODS

Check connecting rods for proper alignment. Discard or straighten any rods that are misaligned.

NOTE: Replace all unserviceable rods with new ones of the SAME weight. Replacement rods are not numbered as to the correct cylinder location and should be marked prior to installation.

Install a new piston pin bushing if inside bushing diameter exceeds 1.2515 inches.

Connecting rod bearing inserts are available in standard size or in 0.010 inch, 0.020 inch and 0.030 inch undersize.

Specifications are as follows:

Crankpin diameter. . .	2.2485 - 2.249 inches
Recommended bearing clearance	0.002 - 0.0035 inch
Rod side play.	0.0095 - 0.013 inch

Bushing Replacement

When replacing piston pin bushings support the connecting rod in a press and press out the worn bushing. To install the new bushing, position the bushing on the connecting rod; make sure oil hole in bushing is in line with oil hole in connecting rod, then use a bushing driver to press the new bushing into place. Ream the excess material from the bushing and then finish hone the bushing to an inside diameter of 1.2505 - 1.2515 inches. Proper clearance between the piston pin and the piston pin bushing is 0.0005 - 0.00175 inch.

> *NOTE: A good fit can be determined if, with a new pin oiled and held in a soft jawed vice, the connecting rod, after being worked a few times will barely fall under its own weight.*

PISTON PINS

Piston pins are 1.24975 inches in diameter and are available only in standard size. The full floating type piston pins are retained in the piston by snap rings.

New pins fit from minus 0.0005 inch to plus 0.00025 inch clearance in the piston (thumb press fit in piston at 160 degrees F).

Fit new pins in connecting rod bushings to 0.0005 - 0.00175 inch clearance. Refer to the "note" under bushing replacement.

Install NEW snap rings when installing piston pins.

INSTALLATION OF PISTON AND CONNECTING ROD ASSEMBLY

1. If the original pistons are serviceable and are to be installed, make sure that the piston and connecting rod are assembled together with the original thrust face of the piston opposite the connecting rod numbers.

> *NOTE: New pistons may be installed with either side being the thrust face.*

2. Stagger the ring gaps, then install the pistons into their original cylinders and MAKE SURE THAT THE CONNECTING ROD NUMBERS ARE OPPOSITE THE CAMSHAFT.
3. If old bearing inserts are to be used, install them into their original location and install the bearing caps. Make sure cap marks are in register and torque connecting rod caps evenly to 70 - 80 ft.-lbs.

> *NOTE: Always use NEW self-locking nuts.*

Cylinder Sleeves

The thin steel dry type sleeves are chrome plated on the inside. Sleeves are manufactured with an inside diameter of 3.6015 - 3.6025 inches.

The top of the sleeves are flanged and when installed must extend a specified distance below the face of the cylinder block. Sleeves fit into the cylinder bores from 0.001 inch loose to 0.001 inch tight.

INSPECTION

Thoroughly clean the sleeves and inspect them for scoring or other damage. Chrome plating is 0.0015 inch thick. If any slight cylinder ridge can be detected or if plating appears to be worn the sleeve MUST be replaced.

REPLACEMENT

To replace the cylinder sleeves proceed as follows: (Assuming piston and connecting rods already removed)
1. Remove the studs from the face of the cylinder block.
2. Use a press with a suitable adapter or a sleeve puller, as shown in Fig. 22A, and remove the sleeve from the top of the cylinder block. The diameter of the cylinder block bore is 3.6875 - 3.6885.

3. After removing the sleeve, THOROUGHLY clean the cylinder block bore, with particular attention given to the top recess for the flange of the sleeve.

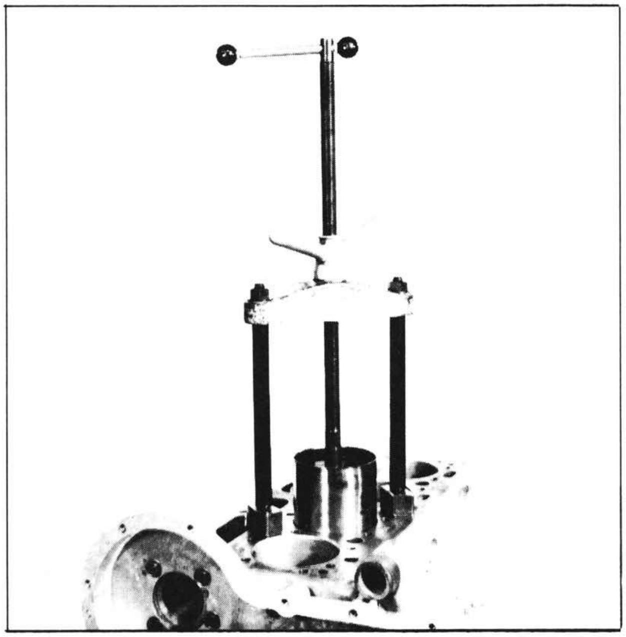

Fig. 22A - Removing Sleeve From Cylinder Block

IMPORTANT: Make sure the bore and sleeve are CLEAN. Also, care must be used in the handling of sleeves, as the slightest damage or burr can cause considerable distortion to the sleeve when installed.

4. Chill the sleeves, then install by pressing them into the block by hand. When correctly installed, the top face of the flange must be 0.001 - 0.009 inch below the top face of the cylinder block as shown in Fig. 23.

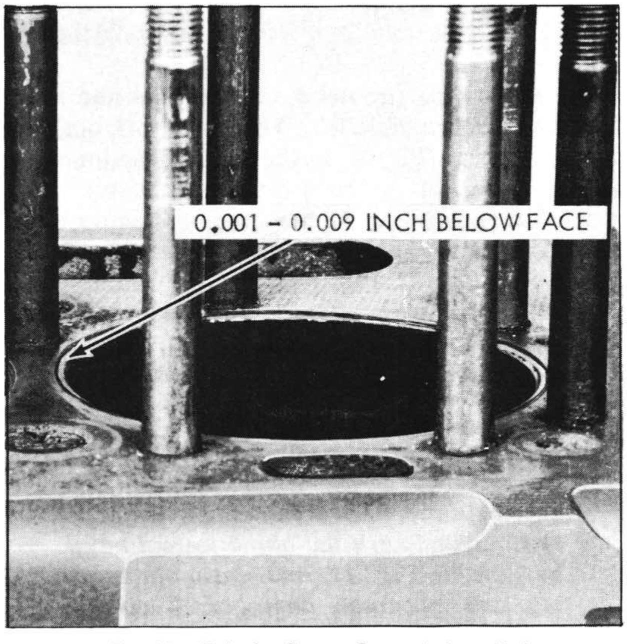

Fig. 23 - Cylinder Sleeve Correctly Installed

5. Make sure the sleeves are fully seated and then measure the inside diameter in two directions (at right angles) at the top, center and bottom of sleeve. Sleeves must be concentric and measure from 3.6015 - 3.6025 inches in diameter.

Timing Gear Cover and Front Crankshaft Oil Seal

The timing gear cover is made of heavy duty cast iron and is manufactured with facings for mounting the water pump, generator bracket and crankcase breather pipe. The cover is also manufactured with an oil filler cover, No. 3, Fig. 24, that can be removed to allow adjustment of the injection pump timing.

The front crankshaft oil seal, No. 4, Fig. 24, is of the spring loaded type and is contained in the timing gear cover.

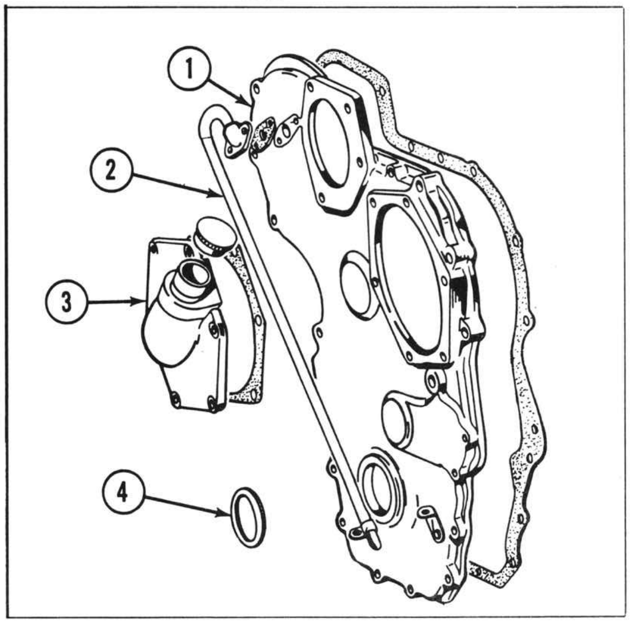

Fig. 24 - Nomenclature

1. Timing Gear Cover
2. Breather Pipe
3. Oil Filler Body Cover
4. Front Crankshaft Oil Seal

REMOVAL

To remove the timing gear cover proceed as follows:

1. Drain cooling system and oil pan.
2. Disconnect headlight wires and remove hood and side panels.
3. Disconnect drag link and on models so equipped unbolt the power steering reservoir and the power steering pump (do not disconnect oil lines) and lay pump and reservoir in grille enclosure.

4. Disconnect air cleaner and radiator hoses.
5. Remove generator.
6. Support tractor under oil pan, also support front end, then unbolt and roll front end assembly away from tractor.
7. Remove the two setscrews securing the by-pass adapter to the water outlet housing. Release the hose clamps and remove the water pump and fan assembly from engine.
8. Release the locking tab and remove the crankshaft starter dog from the front end of the crankshaft.
9. Remove the crankshaft pulley.
10. Remove the crankshaft breather pipe and remove the cap screws securing the timing gear cover, then remove cover from engine and discard old gasket.

> *NOTE: Use care when removing the timing gear cover not to damage the front oil seal.*

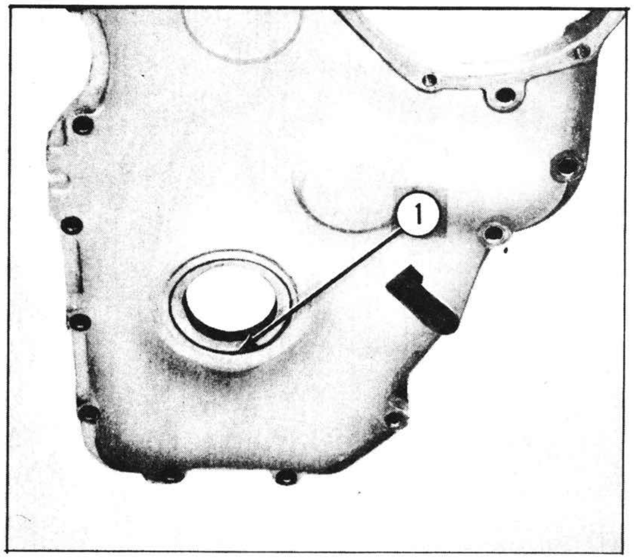

Fig. 25 - New Oil Seal Correctly Installed
1. Seal Positioned 3/32 Inch Below Front Face of Cover

REPLACING THE FRONT OIL SEAL

To install a new front oil seal proceed as follows: (Fig. 25 shows a new oil seal correctly installed)

1. Carefully remove the old oil seal by pressing it OUT THE FRONT OF THE COVER.
2. With the lip of the new oil seal facing TOWARD the engine, carefully align and press the seal INTO THE FRONT OF THE COVER. Position the seal 3/32 of an inch BELOW the front face of the cover to make sure it is concentric with the cover.

INSTALLATION

To install the timing gear cover proceed as follows:

1. Carefully clean all gasket surfaces.
2. Using a new gasket, CAREFULLY install the cover. DO NOT DAMAGE THE FRONT CRANKSHAFT OIL SEAL AS THE FRONT END OF THE CRANKSHAFT ENTERS THE OIL SEAL.
3. To complete cover installation reverse the steps listed under heading "Removal".

Crankshaft and Main Bearings

The crankshaft is machined from a solid nickel chrome molybdenum steel forging and is statically and dynamically balanced. All main bearing and connecting rod journals are induction hardened for maximum service. The crankshaft is supported by five precision non-adjustable type main bearings, as shown in Fig. 26.

New specifications are as follows:

CRANKSHAFT

Main bearing journal diameter	2.7485 - 2.749 inches
Crankpin diameter. . . .	2.2485 - 2.249 inches
Crankshaft end play . .	0.002 - 0.010 inch

MAIN BEARINGS

Bearing clearance limits	0.0023 - 0.0043 inch
Diameter of bearing bore in block	2.9165 - 2.9175 inches

Oil seals are provided at the front and rear ends of the crankshaft. The front oil seal as shown in Fig. 24, is of the spring loaded type and is installed in the timing gear cover. The rear seal is of the rubber core asbestos rope type and is contained in a two-piece seal retainer as shown in Fig. 32.

The doweled main bearing caps are numbered from front to rear as shown in No. 1, Fig. 27, AND CAN NOT BE INTERCHANGED OR REPLACED.

> *NOTE: Cylinder block and main bearing cap bores are machined with the caps in place. For this reason the caps are marked with the block serial number, No. 2, Fig. 27, and if a main bearing cap becomes damaged it will be necessary to replace the cylinder block complete with main bearing caps.*

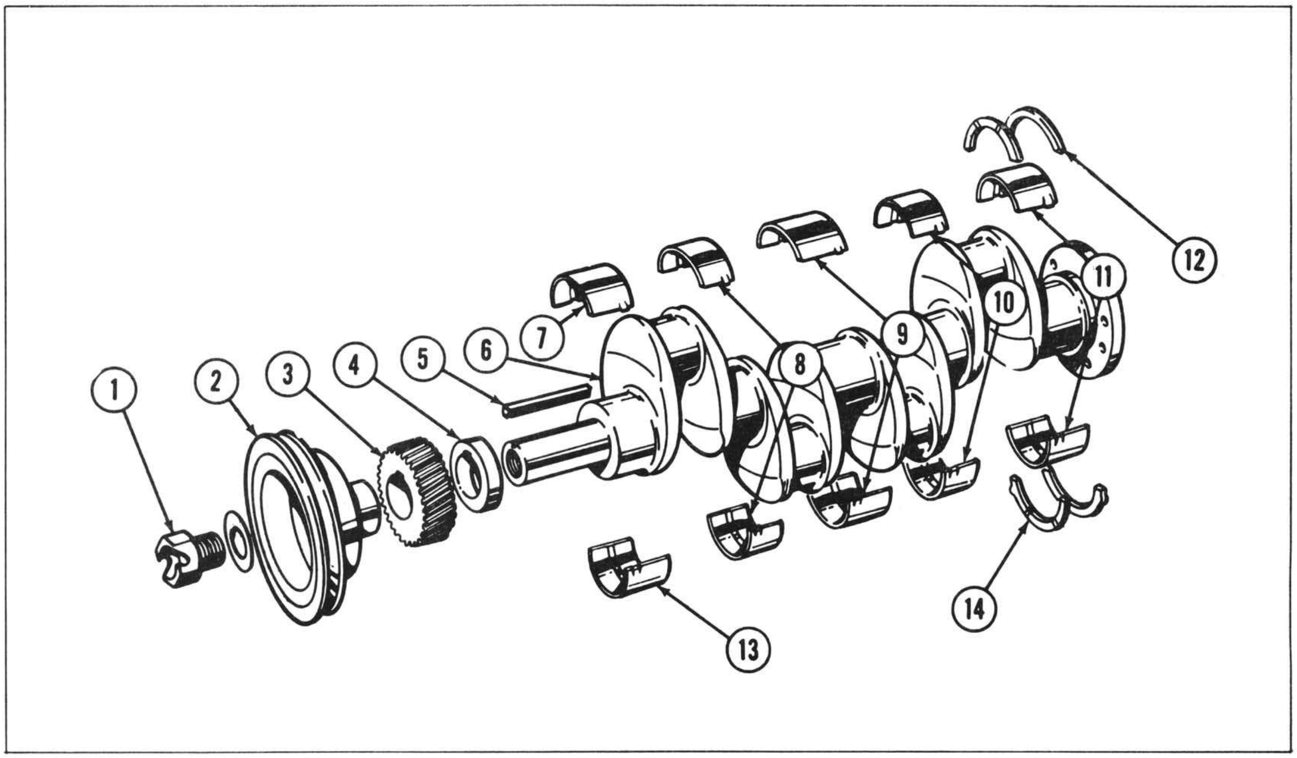

Fig. 26 - Nomenclature and Sequence of Parts

1. Crankshaft Starter Dog
2. Crankshaft Pulley
3. Crankshaft Timing Gear
4. Timing Gear Spacer
5. Timing Gear Key
6. Crankshaft
7. Front Bearing Insert (Upper Half)
8. No. 2 Bearing Inserts
9. No. 3 Bearing Inserts
10. No. 4 Bearing Inserts
11. No. 5 Bearing Inserts
12. Upper Thrust Washers
13. Front Bearing Insert (Lower Half)
14. Lower Thrust Washers

Main bearing inserts are available in standard size, or 0.010 inch, 0.020 inch and 0.030 inch undersize. Upper and lower main bearing inserts are interchangeable for each bearing EXCEPT the front. New rear main bearing inserts can not be installed without removing the engine.

Crankshaft end play is controlled by thrust washers No's. 12 and 14, Fig. 26, which are installed in the block and rear main bearing cap.

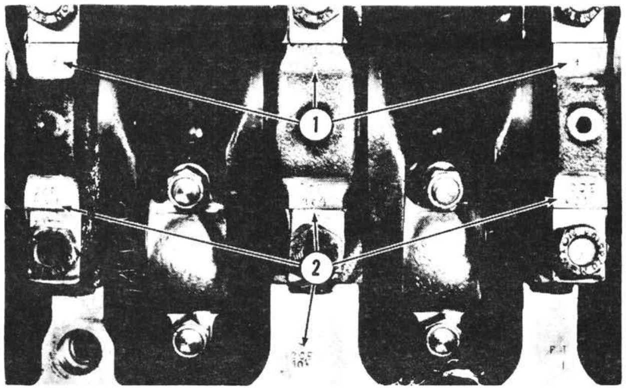

Fig. 27 - Numbered Main Bearing Caps

1. Location Numbers 2. Block Serial Numbers

REMOVAL

1. Separate the engine from the tractor, including the front axle.
2. Remove the clutch assembly, starter motor and transmission housing adapter plate.
3. Remove the water pump, crankshaft pulley, generator and front timing gear cover.
4. Remove the oil pan and oil pump suction and delivery pipes.
5. Remove the bolts and self-locking nuts securing the two halves of the rear oil seal retainer assembly.
6. Remove the connecting rod caps and bearing inserts.

NOTE: Using care not to damage the crankshaft, force the crankshaft, forward, then measure crankshaft end-play using a dial indicator or feeler gauge as shown in Fig. 28. If end-play exceeds 0.010 inch install new thrust washers when assembling engine.

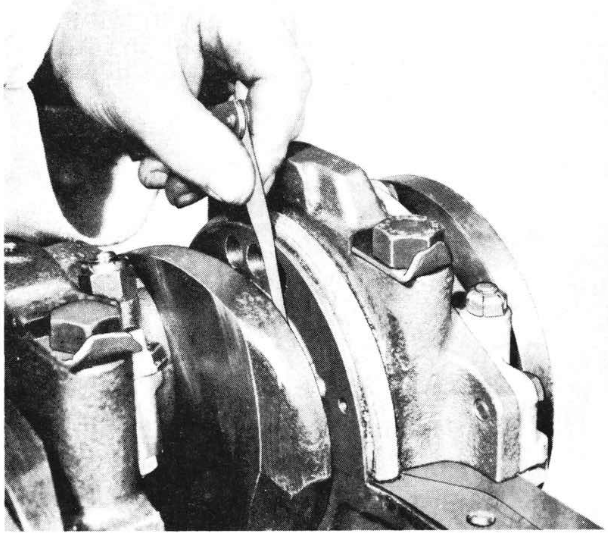

Fig. 28 - Measuring Crankshaft End-Play

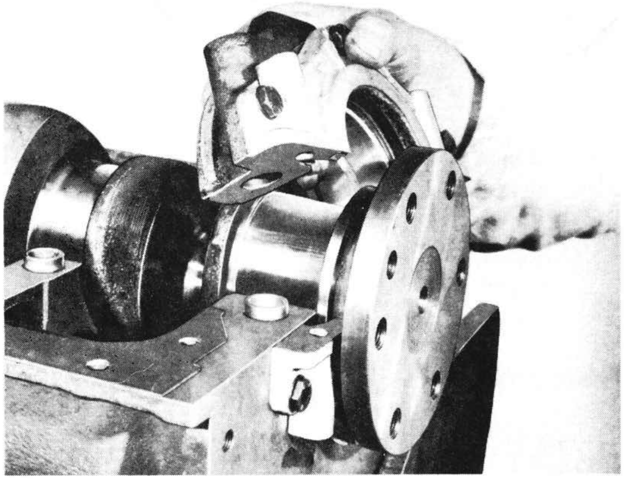

Fig. 29 - Removing the Rear Main Bearing Cap

7. Release the bolt locks and remove the bolts securing the main bearing caps.
8. Remove the main bearing caps using care not to drop either the bearing inserts or thrust washers, see Fig. 29.

> *NOTE: The oil pump may remain bolted to the front main bearing cap as shown in Fig. 30.*

9. Carefully lift the crankshaft from the cylinder block.
10. Remove the crankshaft timing gear and spacer.

> *NOTE: Make sure that all main bearing inserts and caps are identified so that if servicable they may be installed in their original location.*

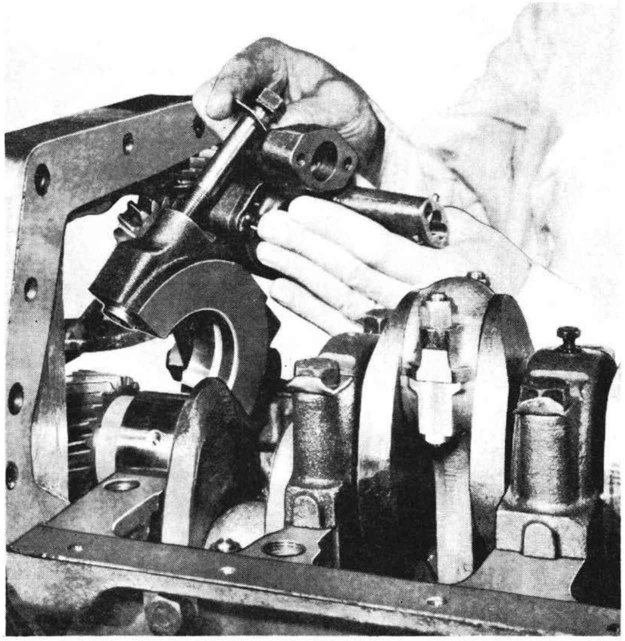

Fig. 30 - Removing Front Bearing Cap with Oil Pump Attached

INSPECTION

Thoroughly clean and inspect the crankshaft as outlined in Group I, Section A, Part 4. Specifications are as follows:

CRANKSHAFT

Main bearing journal diameter	2.7485 - 2.749 inches
Crankshaft end-play	0.002 - 0.010 inch
Crankpin journal diameter	2.2485 - 2.249 inches

MAIN BEARINGS

Diameter of bearing bore in block	2.9165 - 2.9175 inches
Bearing clearance	0.002 - 0.004 inch

If any of the main or crankpin journals are worn beyond specifications, more than 0.0015 inch out-of-round, or tapered more than 0.001 inch, the crankshaft must either be replaced or reground and fitted with undersize bearings.

CRANKSHAFT REGRINDING

Before having the crankshaft reground, check the following points to make sure that it is suitable for regrinding:

1. Inspect the crankshaft for cracks.
2. Measure the main bearing and crankpin journal diameters to determine the next size they can be ground to and fitted with undersize bearing inserts.

NOTE: Main bearing and connecting rod inserts are available in 0.010 inch, 0.020 inch and 0.030 inch undersize.

The crankshaft journals must be ground with a surface finish not to exceed 16 micro-inches and with the following radii:

Main Bearing Journals	
No's. 1,2,3, and 4 journals	0.9375 inch
No. 5 (rear) journal	0.125 inch
Crankpin Journals	
All	0.15625inch

After regrinding, the width of the crankpin journals must not exceed 1.5785 inches. Also, all main and crankpin journals must be free of grinding marks. Remove the sharp edges on the oil holes and again inspect for cracks and demagnetize the crankshaft.

CRANKSHAFT INSTALLATION

1. Install the upper halves of the main bearing inserts in their proper positions and lubricate them.

IMPORTANT: Make sure that all oil passages are clean. New main bearing inserts are not completely interchangeable. Refer to the following table to determine which inserts are interchangeable.

BEARING INSERTS	NO. OF INSERTS
#3 and #5 (rear) bearing, upper and lower halves	4
#1 bearing, upper half only	1
#1 bearing, lower half only	1
#2 and #4 bearing, upper and lower halves	4

2. Install the upper halves of the crankshaft thrust washers (those without locating tabs) on each side of the rear wall of the cylinder block housing with the bronze face toward the crankshaft and the steel face toward the main bearing cap, refer to Fig. 31.

NOTE: A light coat of grease will assist in holding the thrust washers in place until the crankshaft is installed.

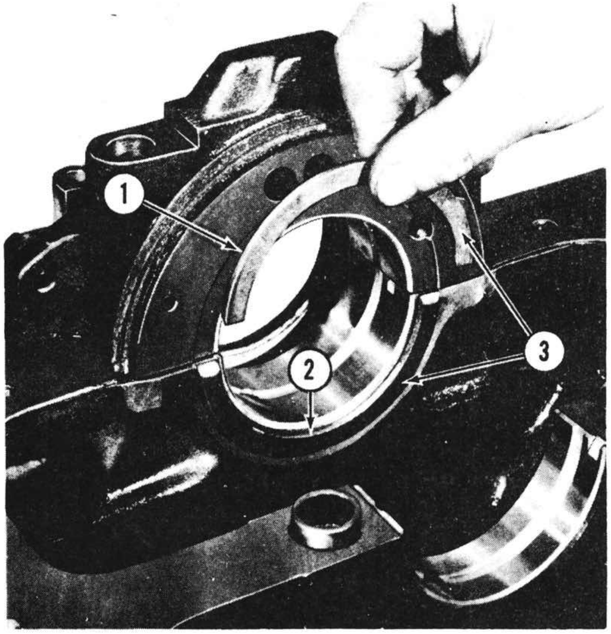

Fig. 31 - Nomenclature

1. Lower Thrust Washer 2. Upper Thrust Washer
3. Bronze Faces Toward Crankshaft

3. Make sure that:
   a. The main bearing inserts are correctly installed.
   b. Bronze faces of thrust washers are toward crankshaft.
   c. The ends of the thrust washers are level with the face of the block.

4. Carefully lower the crankshaft into position.

5. Install the lower main bearing inserts into their respective bearing caps and lightly coat them with oil.

6. Lightly coat the lower rear main bearing thrust washers (those with locating tabs) with grease and position them in the recess on each side of the rear bearing cap. MAKE SURE THAT THE BRONZE FACE IS TOWARD THE CRANKSHAFT.

7. USING NEW BOLT LOCKS install the numbered main bearing caps in their correct locations. Make sure that the bearing caps are properly located and that the locating numbers are on the side OPPOSITE the camshaft. TORQUE MAIN BEARINGS TO 110 - 120 FT.-LBS. AND LOCK THE BOLTS.

8. Using care not to damage the crankshaft, force the crankshaft forward, then measure crankshaft end play using a dial indicator or feeler gauge as shown in Fig. 28. End play must be between 0.002 - 0.010 inch. If end play exceeds 0.010 inch install new thrust washers.

NOTE: Thrust washers are available in standard size or 0.007 inch oversized.

9. Install oil seal retainers complete with new rear oil seal.

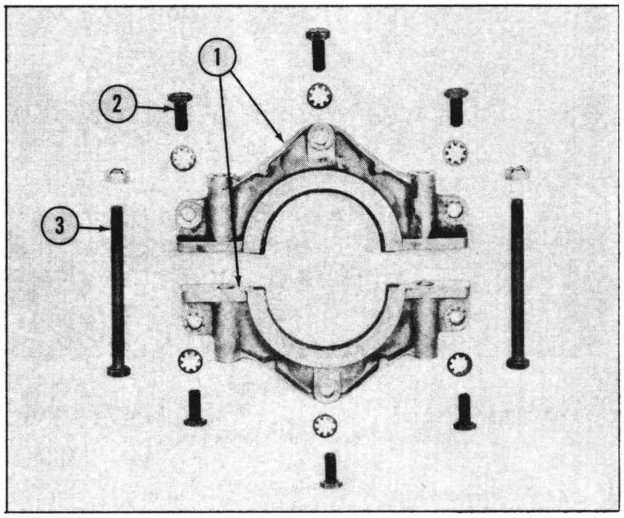

Fig. 32 - Nomenclature

1. Oil Seal Retainer Assembly (With Oil seal installed
2. Cap Screw and Shakeproof Washer
3. Clamping Bolt and Special Self Locking Nut

Rear Crankshaft Oil Seal

The rubber cored asbestos rope type oil seals are contained in a two piece retainer cover assembly as shown in Fig. 32. Each half of the oil seal retainer is machined to accommodate the oil seal. New oil seals can be installed with the crankshaft in position. Fig. 33 shows the rear oil seal retainers properly installed.

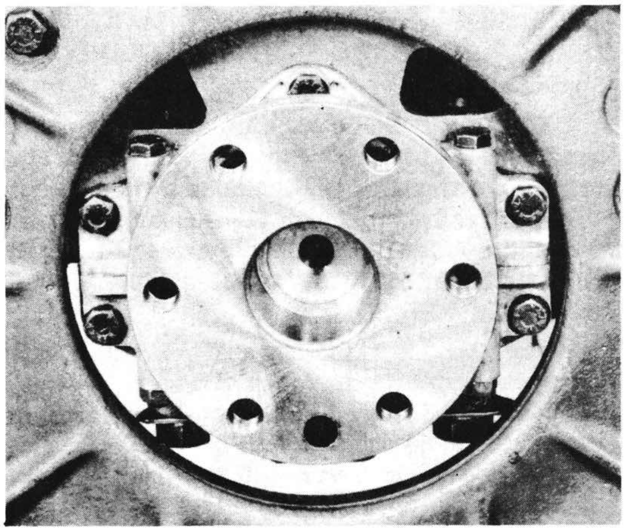

Fig. 33 - Oil Seal Retainer Assembly Correctly Installed

REMOVAL

To remove the rear crankshaft oil seal proceed as follows:

1. Separate engine from transmission housing.
2. Remove clutch assembly and flywheel.
3. Remove the adapter plate from the cylinder block and engine oil pan.
4. Remove the special self-locking nuts from the two clamping bolts that pass through the oil seal retainers and remove the bolts.
5. Unscrew the three bolts from each half of the oil seal retainer and remove the retainers from the cylinder block and rear main bearing cap.

OIL SEAL REPLACEMENT

Before installing new oil seals make sure to carefully clean the seal grooves and old gasket material from the oil seal retainers. SOAK NEW OIL SEALS FOR AN HOUR IN CLEAN ENGINE OIL. To install new oil seals place each half of the seal retainer (one at a time) in a vise and proceed as follows:

1. Press approximately one inch of the new asbestos seal into each end of the groove in the seal retainer, allowing the seal to project 0.010 - 0.020 inch BEYOND both ends of the joint face. This amount of projection assures correct contact between the end faces of the seals, when the retainer halves are installed around the crankshaft.

IMPORTANT: A projection exceeding that quoted above must be avoided, because excess may not settle in the retainer groove, and may be forced over the joint face as the retainer halves are pulled together. Thus the retainers may be held slightly apart and cause an oil leak. Due to the interference between the seal and its groove, it is possible that the seal may not fully seat into the groove, giving the impression that it is too long. EACH SEAL IS OF THE CORRECT LENGTH AND MUST NOT BE TRIMMED AT ANY TIME.

2. The middle of the oil seal will bulge out of the groove and must be pushed in with the fingers, working from the center, until well bedded in the groove. Use a round bar of metal to further bed in the strip by rolling and pressing. MAKE SURE THAT THE SEAL EXTENDS 0.010 - 0.020 INCH BEYOND BOTH ENDS OF THE JOINT FACE as shown in Fig. 34. Any gap at this joint when the seals are installed will allow oil to leak past the seal.

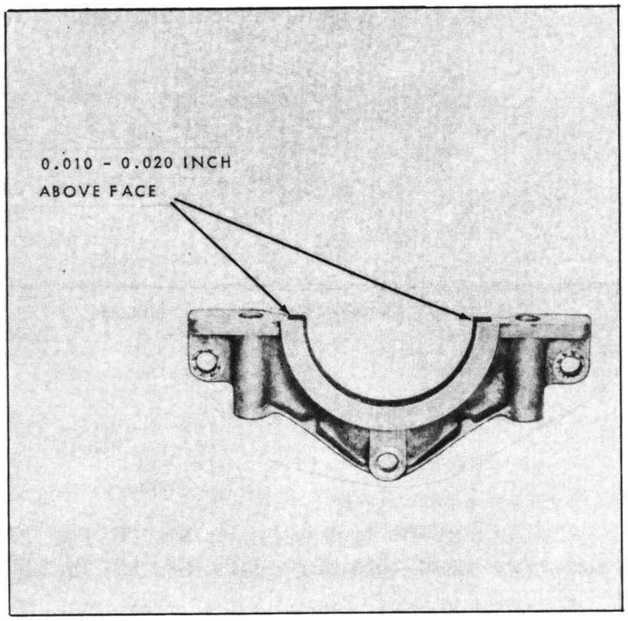

Fig. 34 - Oil Seal Must Extend 0.010 - 0.020 Inch Beyond Face

3. Repeat the above steps for the other half of the seal retainer.

4. Remove all of the old gasket material from the cylinder block and rear main bearing cap face and install new gaskets using a suitable sealing compound.

5. Lightly coat the joint faces of the oil seal retainers with a suitable sealing compound and coat the inside surface diameter of the oil seal WITH GRAPHITED GREASE.

6. Assemble the oil seal retainers around the crankshaft and loosely bolt them together.

7. Position the seal retainer assembly so that the holes align, then LOOSELY bolt it to the block and rear bearing cap using "star"-type washers.

8. Fully tighten the two long clamping bolts.

9. Fully tighten the six set screws securing the seal retainer assembly.

10. Complete reassembly by reversing the steps listed under "Removal".

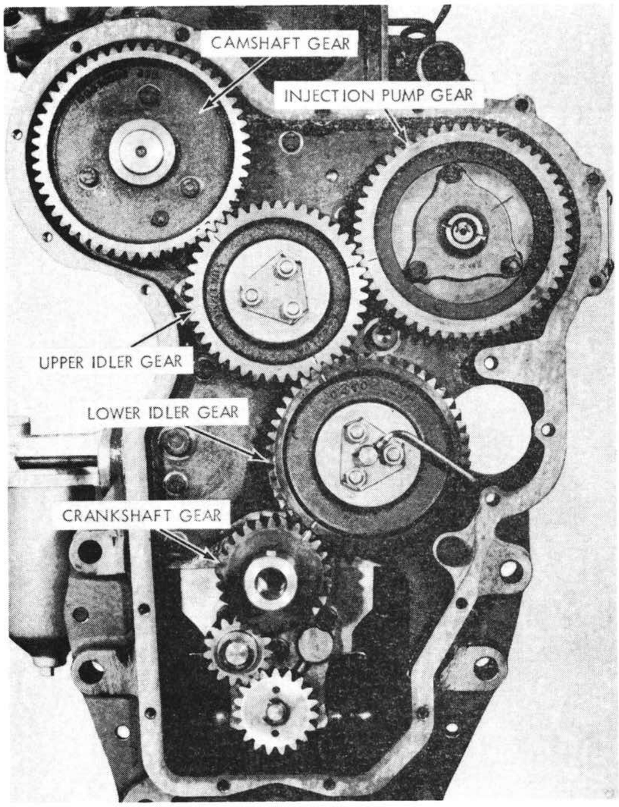

Fig. 35 — Timing Gears and Timing Gear Marks
1. Timing Gear Marks Properly Aligned

CAMSHAFT AND TIMING GEARS

The camshaft and injection pump are gear driven by the crankshaft gear through two idler gears mounted on hubs bolted to the front of the cylinder block, see Fig. 35. The lower idler gear drives the hydraulic pump when the tractor is equipped with power steering. Two flanged bushings of sintered bronze are installed into the front and rear of the lower idler gear.

The injection pump gear has slotted holes to allow adjustment of the fuel injection timing.

All of the timing gears are marked and when reassembling the engine all marks must align with No. 1 piston at T. D. C. on compression stroke, see No. 1, Fig. 35.

> *NOTE: Due to the odd number of teeth in the two idler gears, the complete set of timing gear marks will align only once in more than 2,000 crankshaft revolutions. For this reason, if any of the gears in the timing gear train are to be removed, both idler gears must be removed and the engine timed upon reassembly.*

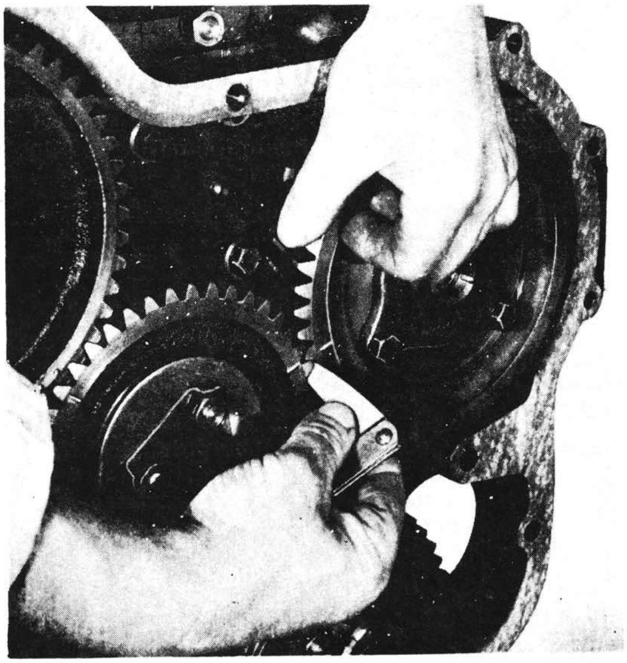

Fig. 36 – Measuring Timing Gear Backlash

CHECKING TIMING GEAR BACKLASH

To check timing gear backlash proceed as follows:

1. Remove the timing gear cover.

2. Check the backlash between the timing gears with a dial indicator or feeler gauge as shown in Fig. 36. The backlash between any two gears in the timing gear train must be between 0.003 - 0.006 inch.

3. If the backlash of the timing gears is not within these limits, the gears must be replaced. Replacement gears are available only in standard size and are marked for correct installation.

REMOVAL OF IDLER GEARS AND HUBS

To remove the idler gears and hubs, refer to Fig. 37, and proceed as follows:

1. Remove the lock wire on the banjo type bolt securing the oil line, No. 14, Fig. 37, to the lower idler gear hub, No. 18, Fig. 37.

2. Remove the banjo bolt and oil line.

3. Unlock and remove the three securing nuts.

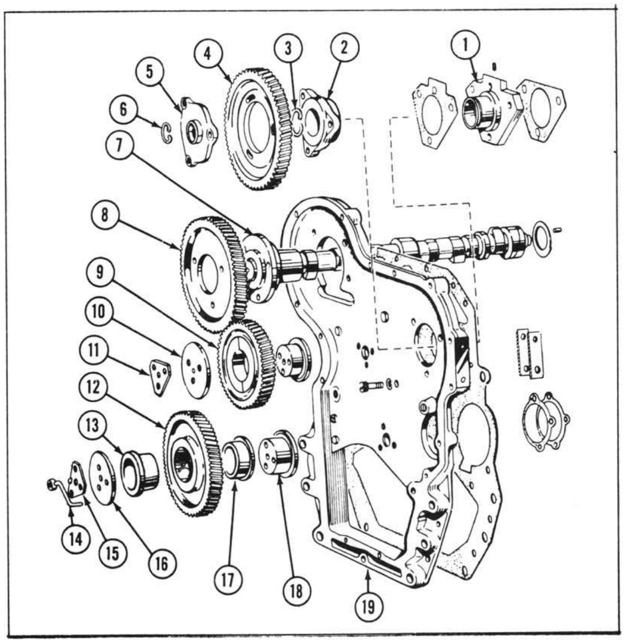

Fig. 37 – Nomenclature and Sequence of Parts

1. Injection Pump Support
2. Injection Pump Gear Hub
3. Hub Retaining Snap Ring
4. Injection Pump Gear
5. Injection Pump Gear Adapter
6. Adapter Retaining Snap Ring
7. Camshaft
8. Camshaft Timing Gear
9. Upper Idler Gear
10. Upper Idler Gear Retaining Plate
11. Idler Gear Lock
12. Lower Idler Gear
13. Lower Idler Gear Bushing
14. Oil Spray Pipe Assembly
15. Idler Gear Lock
16. Lower Idler Gear Retaining Plate
17. Lower Idler Gear Bushing
18. Idler Gear Hubs
19. Timing Gear Housing

4. Remove the lock washer, No. 15, Fig. 37 and idler gear retaining plate, No. 16, Fig. 37.

5. Remove the lower idler gear, No. 12, Fig. 37.

6. Remove the upper idler gear in a similar manner, as shown in Fig. 38.

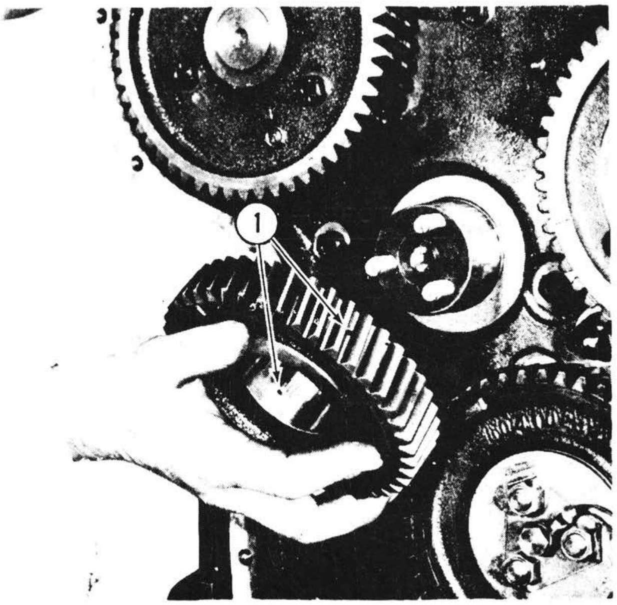

Fig. 38 – Removing Upper Idler Gear
1. Oil Passages

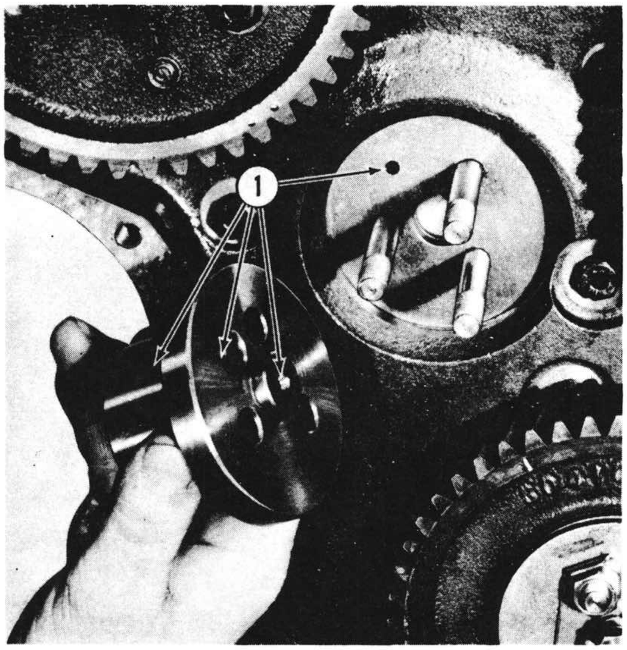

Fig. 39 – Removing Upper Idler Gear Hub
1. Oil Passages

7. The idler gear hubs may now be removed from the studs located in the front of the cylinder block as shown in Fig. 39.

INSPECTION

Discard any parts that are worn or damaged, also make sure that all oil holes are open and clean, see No. 1, Fig. 38 and No. 1, Fig. 39. New specifications are as follows:

UPPER IDLER GEAR AND HUB

Hub Diameter	1.996 -1.997''
Gear Bore Diameter	1.9998-2.0007''
Clearance (Gear-to-Hub)	0.0028-0.0047''
Gear End-Play	0.002 -0.004''

LOWER IDLER GEAR AND HUB

Hub Diameter	1.996 -1.997''
Bushing Bore Diameter	1.9998-2.0007''
Clearance (Gear-to-Hub)	0.0028-0.0047''
Gear End-Play	0.002 -0.004''

INSTALLATION

To install the idler gears and hubs, and to time the engine with the camshaft gear, crankshaft gear and injection pump gear installed, proceed as follows:

1. Install the upper and lower idler gear hubs.

> *NOTE: The hubs are interchangeable, but fit on the three studs in only one position. The boss at the rear of the hub locates in the machined face of the cylinder block.*

2. Turn the crankshaft until the mark on the crankshaft timing gear aligns with the center line of the lower idler gear hub. (No. 1 and No. 4 pistons on T. D. C., and T. D. C. mark on flywheel aligning with mark on inspection hole.)

3. Remove the rocker cover and release the rocker assembly.

4. Install the lower idler gear (one with flanged bushings) so that one timing mark aligns with the mark on the crankshaft gear and the other mark aligns with the center line of the upper idler gear hub.

5. Install the lower idler gear retaining plate, which will only fit in one position on the studs. Lock the three nuts in position.

> NOTE: The lower retaining plate has a center hole that is threaded.

6. Install the oil line and banjo bolt to the lower idler gear retaining plate. Lock the bolt with wire and install the small rubber washer on the end of the oil line behind the timing gear housing.

> *NOTE: The oil line is designed to spray the point of mesh between the lower idler gear and the power steering pump gear, if so equipped.*

7. Turn the camshaft gear and the injection pump drive gear so that their timing marks align with the upper idler gear hub.

8. Install the upper idler gear so that the three timing marks align with the marks on the camshaft gear, injection pump gear and lower idler gear.

9. Make sure that all of the timing gear marks are aligned as shown in Fig. 35, then install the upper idler gear retaining plate and lock the three nuts in position.

10. Secure the rocker assembly in position, then adjust the valves and complete reassembly

Camshaft

The camshaft is made of heavy-duty cast iron with chill-hardened cams and is mounted high on the right hand side of the cylinder block in such a position that it does not require the use of push rods. The camshaft is supported by three bearings that are machined directly into the cylinder block. Camshaft end-play is controlled by a 360 degree thrust plate located in a recess in the front of the cylinder block and a boss in the inside of the timing gear cover.

REMOVAL

To remove the camshaft proceed as follows:

1. Remove the timing gear cover and fuel tank.

2. Turn the engine until No. 1 piston is at T. D. C. on compression stroke.

3. Remove the rocker shaft assembly, fuel pump and idler gears.

4. Lift the tappets and remove the camshaft (with or without its gear) from the cylinder block as shown in Fig. 40, using care not to damage the journals, cams, or the tappets.

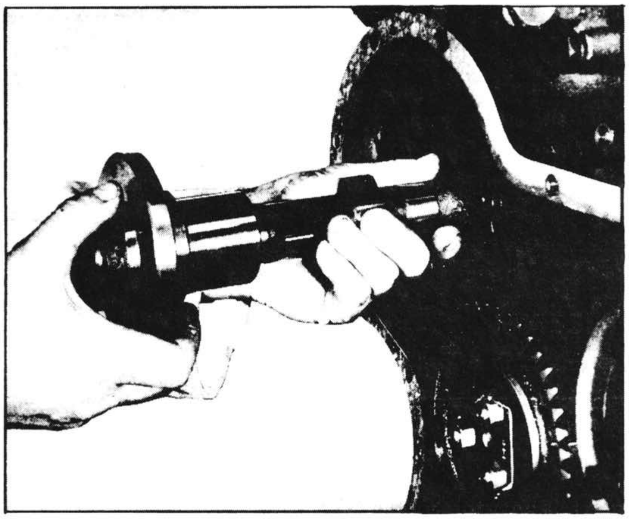

Fig. 40 – Removing the Camshaft

INSPECTION

The camshaft should be inspected as follows:

1. Inspect the camshaft journals and lobes. If the journals are excessively scored, nicked or discolored by heat, or if the lobes are pitted, or rough, the camshaft must be replaced.

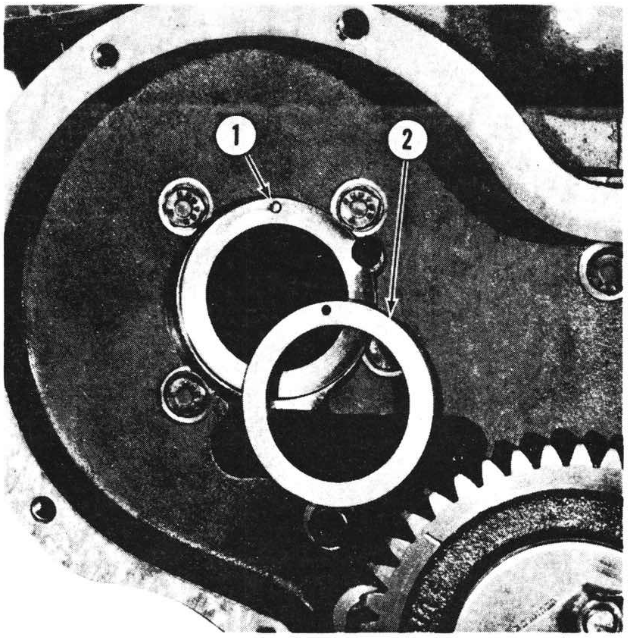

Fig. 41 – Camshaft Thrust Plate and Locating Pin
1. Thrust Plate Locating Pin 2. Camshaft Thrust Plate

2. Measure the diameter of the bearing journals for wear and out-of-round with a micrometer. If journal diameters are worn, or out-of-round, or if the camshaft lobes are worn, the camshaft must be replaced.

New camshaft specifications are as follows:

Front Journal	1.869-1.70 inches
Center Journal.	1.859-1.860 inches
Rear Journal.	1.839-1.840 inches
Cam Lift (Intake & Exhaust). .	0.3085-0.3165 inch

3. Measure the camshaft bearing bores in the block with a hole gauge and micrometer. Then compare each bore diameter to its mating journal diameter. Correct clearance between the camshaft bearing journals and the camshaft bores is 0.004-0.008 inch.

4. Remove the camshaft thrust plate, No. 2, Fig. 41, and measure its thickness. Replace the thrust plate if its thickness is less than 0.125 inch, or if when installed into its recess it is positioned more than 0.003 inch below the face of the block.

INSTALLATION

1. Lift the tappets and while slowly turning the camshaft carefully install it (with or without its gear) into the block.

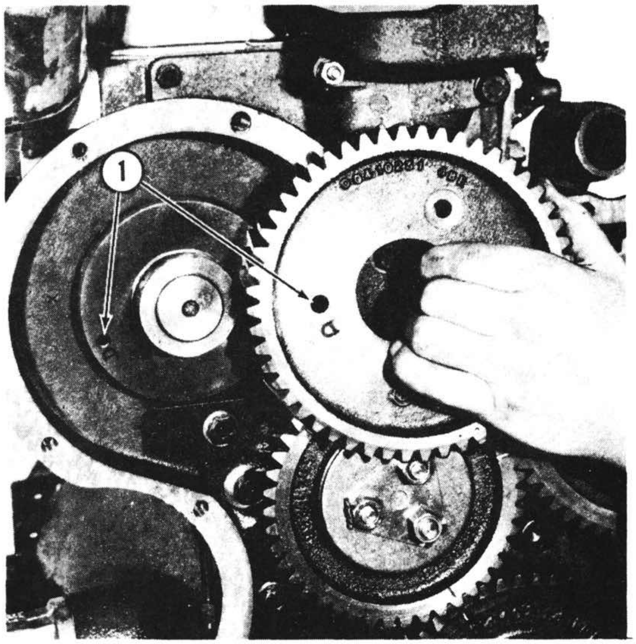

Fig. 42 - Camshaft Gear and Hub Marked For Correct Installation
1. Holes Marked "D" Must Align When Installing Gear

NOTE: Make sure that the thrust plate in the cylinder block is installed and properly located on the locating pin, No. 1, Fig. 41.

2. Install the camshaft gear if it has been removed from the camshaft.

To install the camshaft gear, proceed as follows:

a. Observe on the hub of the camshaft and on the front of the camshaft gear, the bolt holes with the letters "D" stamped next to them. See No. 1, Fig. 42.

b. Install the camshaft gear to the camshaft, making sure that the holes (with the letter "D" stamped next to them) are aligned.

3. Turn the camshaft until the tappets of No. 4 cylinder start "rocking" (timing mark positioned at 5 o'clock). This is the approximate position for aligning the timing gear marks.

4. Install the idler gears and time the engine as outlined on page 25.

Injection Pump Drive and Support

The injection pump driving mechanism consists of three parts:

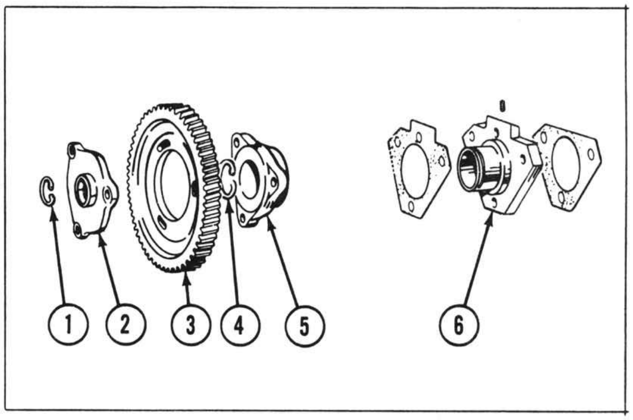

Fig. 43 - Nomenclature and Sequence of Parts
1. Adapter Retaining Snap Ring
2. Injection Pump Gear Adapter
3. Injection Pump Gear
4. Hub Retaining Snap Ring
5. Injection Pump Gear Hub
6. Injection Pump Support

1. The gear hub, No. 5, Fig. 43.

2. The injection pump gear, No. 3, Fig. 43.

3. The gear adapter, No. 2, Fig. 43.

The injection pump gear hub turns on a spindle which is an integral part of the injection pump support, No. 6, Fig. 43.

REMOVAL

To remove the injection pump gear and hub, proceed as follows:

1. Remove the idler gears and release the rocker assembly.

2. Remove the three set screws and spring washers securing the injection pump adapter and gear.

3. Remove the injection pump gear adapter, leaving the splined quill shaft, No. 4, Fig. 46, in the injection pump.

NOTE: A snap ring, No. 1, Fig. 43, is positioned inside the front of the adapter. This snap ring holds the injection pump quill shaft in position.

4. Remove the injection pump gear from the hub.

5. Remove snap ring, No. 4, Fig. 43, and remove the hub from the support spindle.

NOTE: The injection pump support can be replaced after removing the fuel injection pump.

INSPECTION

Discard parts that are worn or damaged. New specifications are as follows:

Injection Pump Support Spindle Diameter	1.6225-1.6238 inches
Hub Bore Diameter	1.6245-1.626 inches
Clearance (Spindle-to-Hub)	0.0007-0.0035 inch
Hub End-Play	0.003-0.011 inch

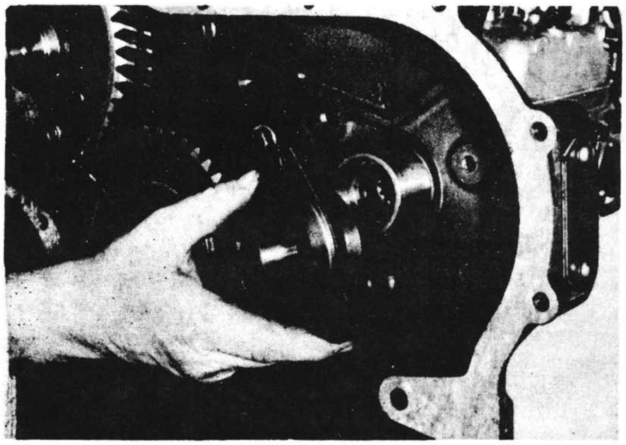

Fig. 44 – Installing the Injection Pump Gear Hub

INSTALLATION

To install the injection pump gear and hub, proceed as follows:

1. Install the hub onto the support spindle as shown in Fig. 44, then install the snap ring.

2. Position the injection pump gear onto the hub with the bolt holes centered between the ends of the slots, see Figs. 45 and 46.

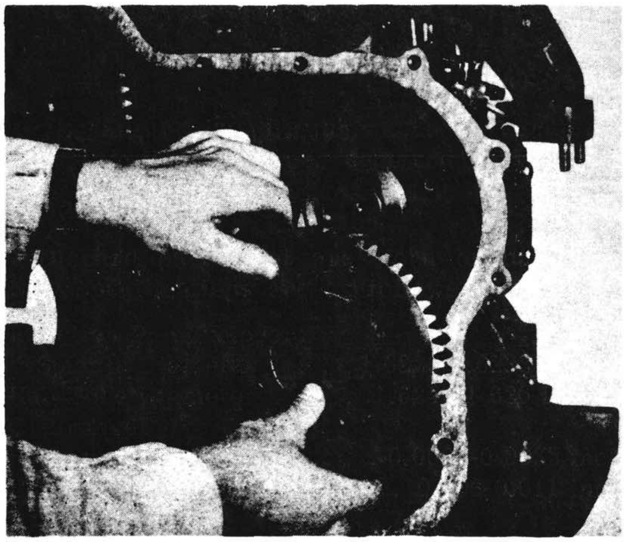

Fig. 45 – Installing the Injection Pump Gear

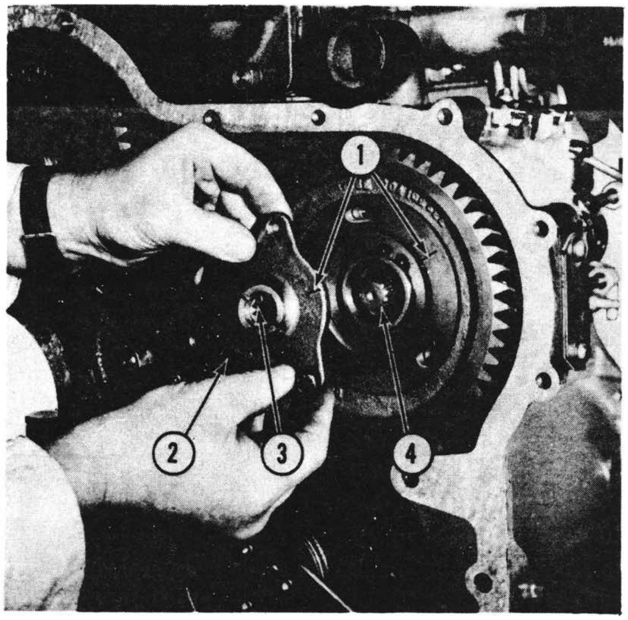

Fig. 46 – Installing the Injection Pump Gear Adapter

1. Adapter and Gear Timing Marks
2. Injection Pump Gear Adapter
3. Adapter Retaining Snap Ring
4. Master Spline on Quill Shaft

3. Observe the timing mark scribed on the adapter and on the front of the injection pump gear, see No. 1, Fig. 46. Position the gear adapter to the gear and engage the master spline on the injection pump quill shaft, No. 4, Fig. 46, into the corresponding spline in the adapter.

4. With the adapter and the gear timing marks aligned, install and tighten the set screws and washers.

5. Install the idler gears making sure that all timing marks align, then secure the rocker assembly and adjust the valves.

> *NOTE: Replacement injection pump gears and adapters are not manufactured with timing marks, No. 1, Fig. 46. When replacing the injection pump gear, time the injection pump by following the procedure listed on page 29, then mark the injection pump gear and adapter to indicate their proper alignment.*

CHECKING VALVE TIMING

Make sure the valve clearances of No. 4 cylinder are set at .012 inch. Then rotate the crankshaft until the intake valve gap on No. 4 cylinder will make a distinct drag on a .002 inch feeler gauge. This drag should occur at 13 degrees before T. D. C. or 1.53 inches before the T. D. C. mark on the rim of the flywheel.

The bolt holes in the camshaft gear are drilled in such a manner that it is possible (only when necessary) to adjust the camshaft timing in relation to the crankshaft. The bolt holes are equidistant and by positioning the gear to either of the other two positions, in which it can be secured to the camshaft, an adjustment of 1/3 (one-third) of a tooth may be made.

NOTE: One-third of a tooth on the camshaft is equivalent to 4.6 degrees on the flywheel.

Advancing Valve Timing

To advance the valve timing 4.6 degrees in relation to the flywheel, remove the bolts securing the camshaft gear and turn the gear on the camshaft hub in the normal direction of engine rotation (counter-clockwise) until the next set of holes line up. Replace the bolts and tighten securely.

Retarding Valve Timing

To retard the valve timing 4.6 degrees in relation to the flywheel, turn the camshaft gear on the camshaft hub in the opposite direction of engine rotation (clockwise) until the next set of holes line up.

After any adjustment of the valve timing, the old timing marks must be removed and new marks made.

NOTE: Due to the fact that the bolt holes in the camshaft gear are slightly larger than the bolts, a fine adjustment of the valve timing can be made as follows:

(1) Loosen the bolts securing the gear.

(2) Turn the gear as much as possible in the desired direction and retighten bolts.

Injection Pump Timing

CHECKING TIMING

To check the injection pump timing, proceed as follows:

1. Remove the plug from the inspection hole in the transmission housing.

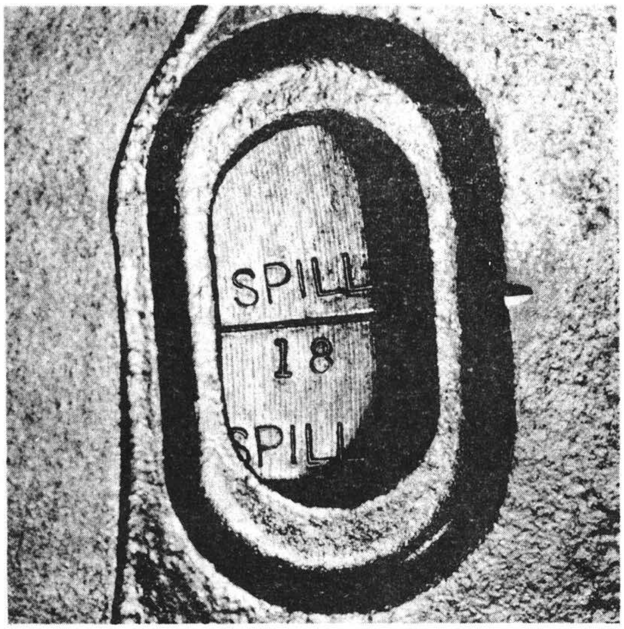

Fig. 47—Flywheel Timing Mark Aligned With Inspection Hole Mark

2. Remove the inspection cover from the side of the injection pump.

3. Turn the crankshaft back 90 degrees and then slowly turn it forward in the direction of normal rotation until the spill 18 or the spill 20 mark on the front face of the flywheel appears in the middle of the inspection hole as shown in Fig. 47.

NOTE: Early model engines are equipped with flywheels marked spill 18 and spill 23. Fuel injection pumps on these engines must be timed to SPILL 18.

Late model engines have flywheels marked spill 20, fuel injection pumps on these engines must be timed to spill 20.

4. With the crankshaft positioned at 18 degrees or 20 degrees B.T.D.C., the scribe line marked "C" on the rotor of the injection pump must align with the scribe line across the lower eye of the snap ring fixed in the pump body. See Fig. 48.

ADJUSTING PUMP TIMING

If the scribe line marked "C" does not align with scribe line on snap ring, proceed as follows:

1. Remove the oil filler cover from the front of the timing gear cover.

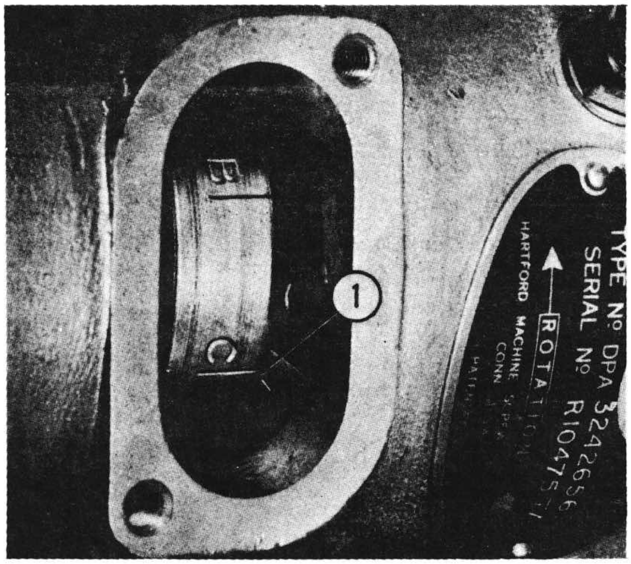

Fig. 48 — Injection Pump With Timing Cover Removed
1. Rotor and Snap Ring Lines Properly Aligned

2. Loosen the three cap screws securing the injection pump gear and adapter.

3. With the bolts loosened, turn the adapter and hub in the required direction to bring the scribe line marked "C" into alignment with the scribe line on the snap ring as shown in Fig. 48.

4. After adjusting, tighten the adapter bolts and replace the oil filler cover and inspection covers.

Timing Gear Housing

REMOVAL

To remove the timing gear housing, proceed as follows:

1. Support the engine under the oil pan, and remove the hood and side panels, fuel tank, radiator assembly, front axle and front axle support.

2. Remove the generator.

3. Remove the timing gear cover.

4. Remove the high pressure and low pressure fuel lines, then remove the fuel injection pump and quill shaft.

5. Remove the rocker assembly and the two idler gears.

6. Remove the camshaft with its gear.

7. Remove the injection pump timing gear mechanism in the following order:

a. Gear adapter
b. Injection pump gear.
c. Injection pump gear hub.
d. Injection pump support.

8. Remove the set screws securing the housing to the cylinder block and oil pan, noting the position of each screw in the block.

9. Tapping from the rear, remove the timing gear housing from the cylinder block, noting the locating dowel between the housing and block.

INSTALLATION

To install the timing gear housing, proceed as follows:

1. Install a new gasket onto the front face of the cylinder block and oil pan.

NOTE: Do not use a hardening type sealing compound between the gasket and the oil pan.

2. Install the timing gear housing.

3. Install the camshaft with its gear.

4. Install the injection pump driving mechanism in the following order:

a. Install the injection pump support.

b. Install the injection pump gear hub onto the front of the injection pump support and install snap ring.

c. Install the injection pump gear and adapter and align the pump timing marks.

NOTE: Make sure that the gear is installed in the one position where the bolt holes in the hub are centered in the gear slots.

5. Install the fuel injection pump and quill shaft as shown in Fig. 49. Align timing marks on the injection pump flange and the support flange before tightening the set screws.

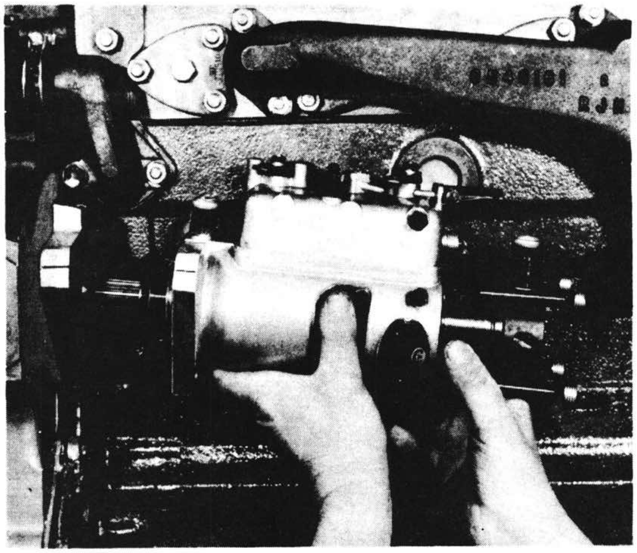

Fig. 49 — Installing the Fuel Injection Pump and Quill Shaft

6. Turn the camshaft gear, injection pump gear and crankshaft gear to their approximate positions for aligning the timing gear marks, then install the idler gears as outlined on page 25.

7. Make sure all timing marks are aligned and complete reassembly.

GROUP 1 - SECTION C - PART 3

PART 3 - FUEL AND AIR SYSTEM SERVICING

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FUEL AND AIR SYSTEM

The fuel and air system of the 4A-203 engine is shown in Figs. 1 and 2.

The essential parts of the fuel system are the fuel tank, fuel shut-off valve, fuel pump, primary fuel filter, secondary fuel filter, fuel injection pump, fuel lines and injectors. In operation, fuel is drawn from the tank by the fuel pump through the sediment bowl assembly. From the sediment bowl fuel flows through the primary and secondary fuel filters to the injection pump. The fuel is then metered and at the proper time pumped under high pressure to the injectors where it is forced into the combustion chambers.

The air system is composed of the air cleaner, connecting tubing, manifolds and thermostart (cold weather starting equipment). The air is drawn into the cylinders through the air cleaner and the intake manifold. The thermostart which is inserted into the intake manifold pre-heats the air before it enters the cylinders.

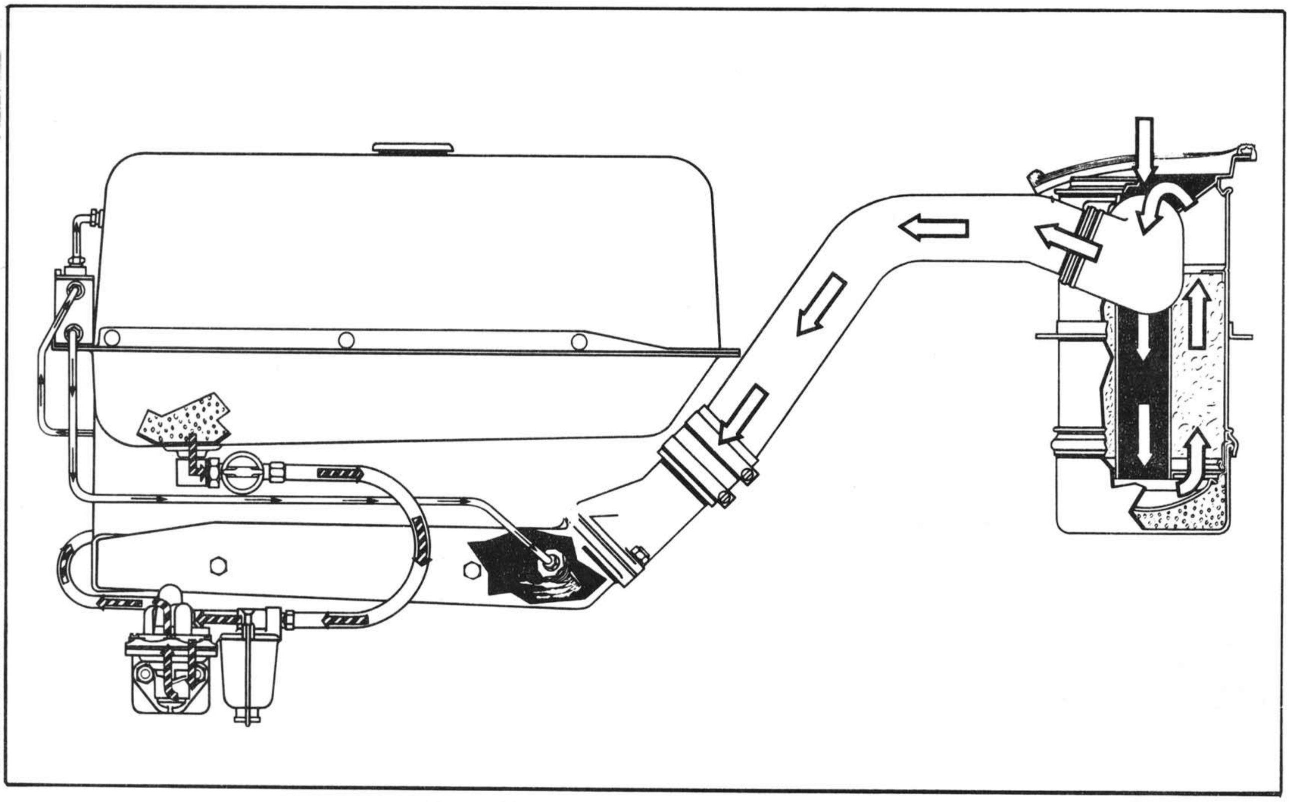

Fig. 1. Fuel and Air System of 4A-203 Engine

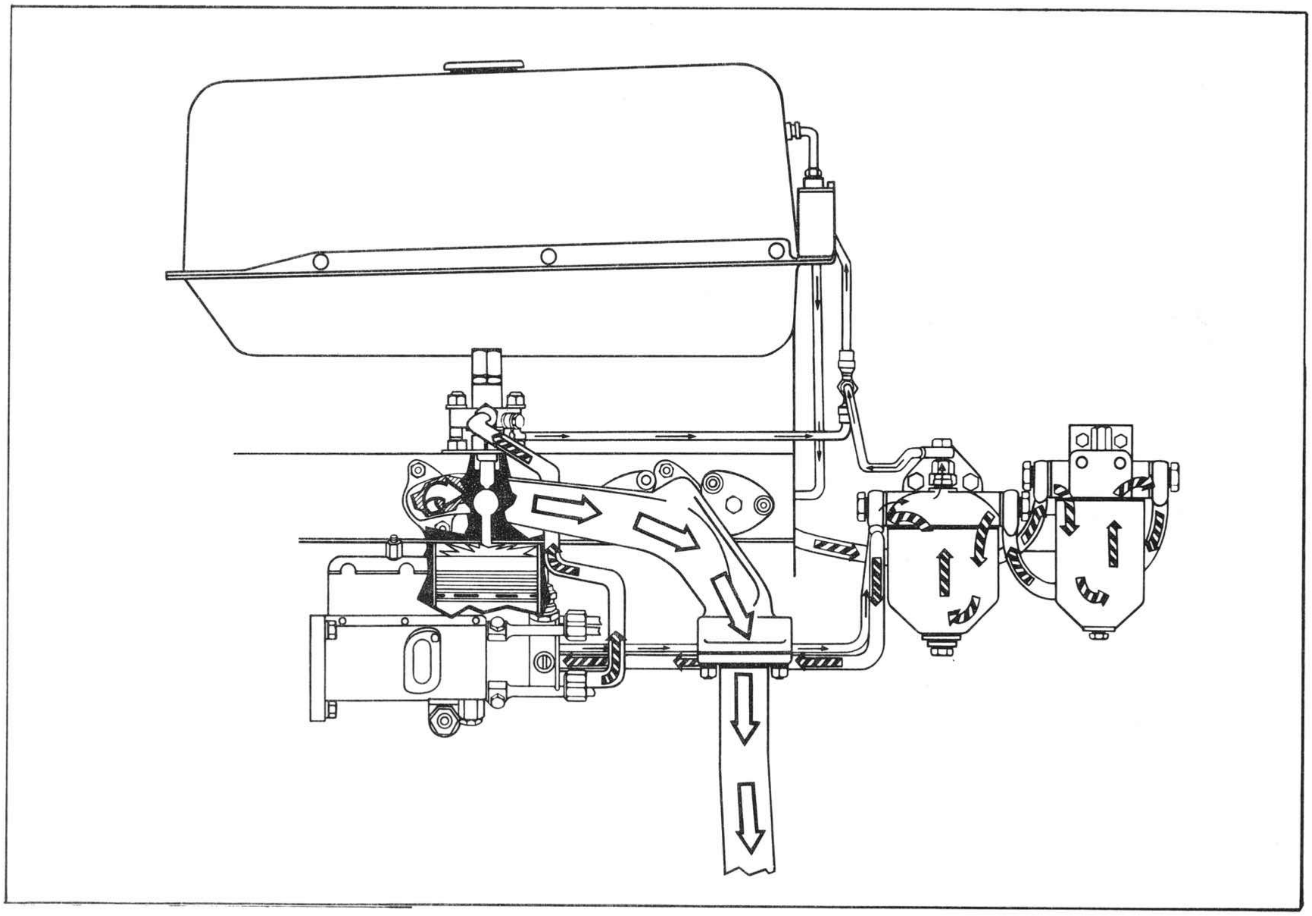

Fig. 2. Fuel and Air System of 4A–203 Engine

IMPORTANT: The engine must be throughly cleaned before removing the fuel injection pump or any of the fuel lines and injectors. If possible, clean the engine with a steam cleaner. If steam is not available, clean the engine with a suitable solvent and rinse with water under hose pressure; then use compressed air to blow the engine clean and dry. ALSO, cap or otherwise cover all fuel openings to prevent dirt from entering the Fuel system. FAILURE TO OBSERVE THESE PRECAUTIONS WILL ALLOW DIRT TO ENTER INTO THE SYSTEM AND WILL RESULT IN ERRATIC ENGINE OPERATION AND DAMAGE TO THE PRECISION PARTS IN THE INJECTION PUMP AND INJECTORS.

TROUBLE SHOOTING

FAILURE TO START

Starting difficulties are not always caused by faulty fuel injection equipment and may result from a low cranking speed, condition of engine and other factors.

The most frequent starting difficulties caused by the fuel system and their remedies are listed as follows:

CAUSE	REMEDY
1. No fuel supply to injection pump.	Fill fuel tank or open fuel shut-off valve.
2. Injection pump shut-off control rod in "stop" position.	Move control rod to "Run" position.
3. Air in fuel system.	Check fuel connections and bleed fuel system of air.
4. Dirty or clogged fuel filters.	Inspect filters for clogging. If clogged, replace the filters and bleed the fuel system of air.
5. Water in Diesel fuel.	Drain fuel system, refill tank with clean fuel and bleed the fuel system of air.
6. Low atmospheric temperature.	Use cold weather starting equipment.
7. Wrong injection pump timing.	Check injection pump timing, adjust if necessary.

ERRATIC ENGINE OPERATION

Possible causes of rough running, with their appropriate remedies are listed as follows:

CAUSE	REMEDY
1. Engine "missing" on one or more cylinders.	Locate cylinder that is least affecting engine operation by loosening the fuel line at the injector - if no change in engine operation is noticed, that cylinder is "missing". Check delivery of fuel from pump, cylinder compression, and/or test the injector to determine cause.
2. Air in fuel system.	Check all connections and bleed the fuel system of air.
3. Clogged fuel filters or air cleaner.	Throughly inspect and service as required.
4. Engine operating temperature too low.	Test thermostat for proper operation. Replace if defective.
5. Poor or wrong type fuel.	Use either #1 or #2 grade fuel oil (depending upon season) that meets specifications.

PRIMING THE FUEL SYSTEM

In order for the tractor fuel system to function properly it is very important that (1) fuel be kept clean and (2) there be no air in the system. Air in the fuel system causes an air lock, which prevents the proper amount of fuel from reaching the fuel injection pump. As a result, the engine may not start, or will be difficult to start and engine performance will be affected.

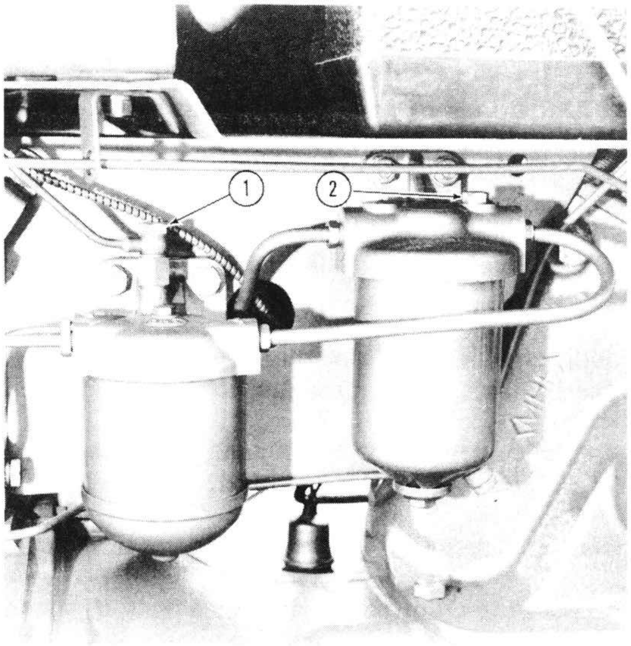

Fig. 3. Fuel Filter Vent Plugs

1. Secondary fuel filter leak-off line bolt
2. Primary fuel filter vent plug

The fuel system must be bled of air if any of the following situations have occurred:

1. If engine runs out of fuel from either an empty tank, or failure to open the fuel tank shut-off valve.

2. If any component of the fuel system has been disconnected or removed.

3. If the engine has been in storage for a considerable period of time.

To Prime the fuel system, proceed as follows:

1. Open the fuel shut-off valve.

2. Loosen the air vent, No. 2, Fig. 3, on the primary fuel filter.

3. Pump the manual lever on the primary fuel pump until fuel free of air comes out of the filter vent. Tighten the vent plug securely.

> *NOTE: In instances where the engine stops with the fuel pump rocker arm in the fully depressed position, it will be necessary to turn the engine slowly until the camshaft releases the arm and will allow full movement of the diaphragm in the fuel pump.*

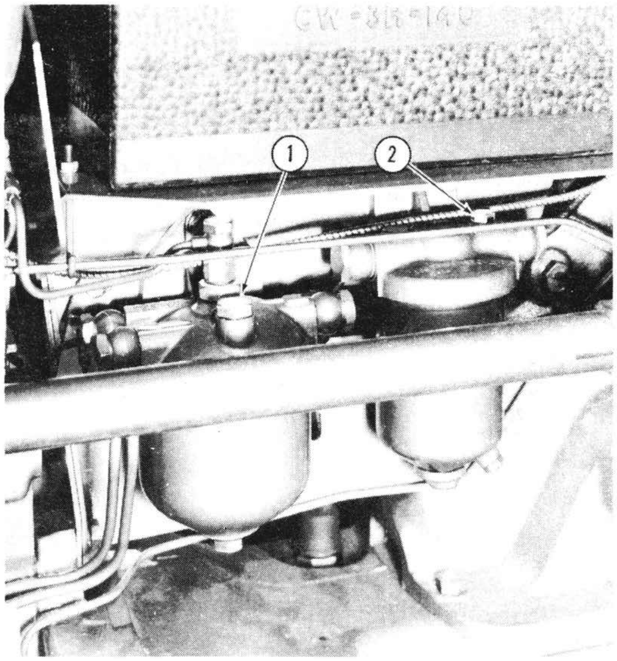

Fig. 4. Early Type Fuel Filters

1. Secondary fuel filter vent plug
2. Primary fuel filter vent plug

4. Loosen the vent, No. 1, Fig. 3, or, No. 1, Fig. 4, (depending on model) on the secondary fuel filter and operate the fuel pump manual lever until fuel free of air comes out of the filter. Tighten the vent plug.

5. Loosen the lower vent plug, No. 1, Fig. 5, on the injection pump body and operate the fuel pump manual lever until fuel free of air flows out of the vent plug.

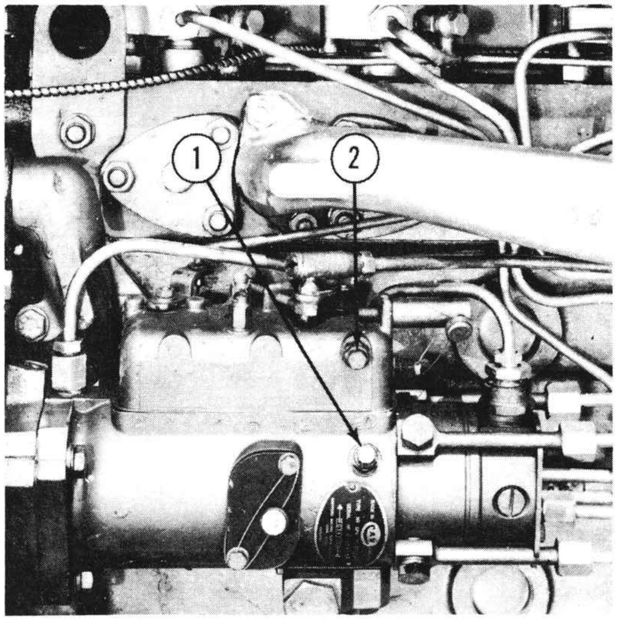

Fig. 5. Injection Pump Vents

1. Lower vent plug 2. Upper vent plug

6. Loosen the upper vent, No. 2, Fig. 5, on the injection pump body and operate the fuel pump manual lever until fuel free of air flows from the port. Tighten the vent plug.

7. Operate the fuel pump manual lever 10 additional times to insure that there is fuel in the bleed back lines to the second stage filter.

8. Loosen two of the high pressure fuel lines at the injector connection. Turn the engine over with the starting motor until fuel free of air escapes from the high pressure line ends. Tighten the two connections.

9. Turn the engine over with the starter until the engine starts.

> *IMPORTANT: The fuel system must be thoroughly bled of air or the engine will not operate properly. Also, do not operate the starter continuously for more than 15 seconds without allowing it to cool.*

FUEL TANK

The fuel tank shown in Fig. 6, has a capacity of 13-3/4 U.S. gallons and does not incorporate a reserve supply of fuel for engine operation.

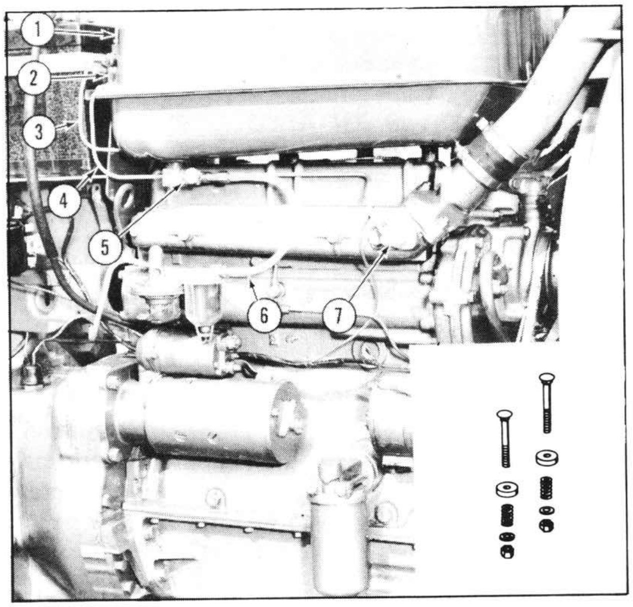

Fig. 6. Nomenclature

1. Line assembly — reserve tank to fuel tank
2. Reserve tank assembly
3. Line assembly — reserve tank to fuel feed back line
4. Line assembly — reserve tank to manifold heater
5. Fuel shut-off
6. Line assembly — shut-off to fuel pump
7. Intake manifold heater (thermostart)

The reservoir, No. 2, Fig. 6, at the rear of the fuel tank provides fuel for the cold starting aid and also allows any air purged by the secondary fuel filter to bleed back to the fuel tank.

REMOVAL

To remove the 13-3/4 gallon fuel tank, refer to Fig. 6 and proceed as follows:

1. Disconnect the head lights if so equipped, then remove hood and side panels.

2. Disconnect and remove batteries and battery strap assembly.

3. Shut-off the fuel valve and remove the following parts:

a. Main fuel line, No. 6, Fig. 6, from tank.

b. Lower fuel line, No. 4, Fig. 6, from reservoir to intake manifold heater, No. 7, Fig. 6.

c. Upper fuel line, No. 3, Fig. 6, from leak off line to reservoir.

d. Fuel line, No. 1, Fig. 6, from reservoir to main fuel tank.

e. Nuts and springs from bolts securing the fuel tank.

4. Carefully lift the tank and remove it from tractor.

> *IMPORTANT. Cover all open fuel lines and connections. CLEANLINESS CANNOT BE OVER-EMPHASIZED.*

INSTALLATION

To install the fuel tank, reverse the steps listed under "Removal".

> *NOTE: Make sure to install the rubber pads above the tank supports. See sequence of parts shown in Fig. 6.*

FUEL PUMP

Fuel is transferred from the fuel tank to the injection pump by a mechanically operated diaphragm type fuel pump. The fuel pump is mounted on the right hand side of the engine

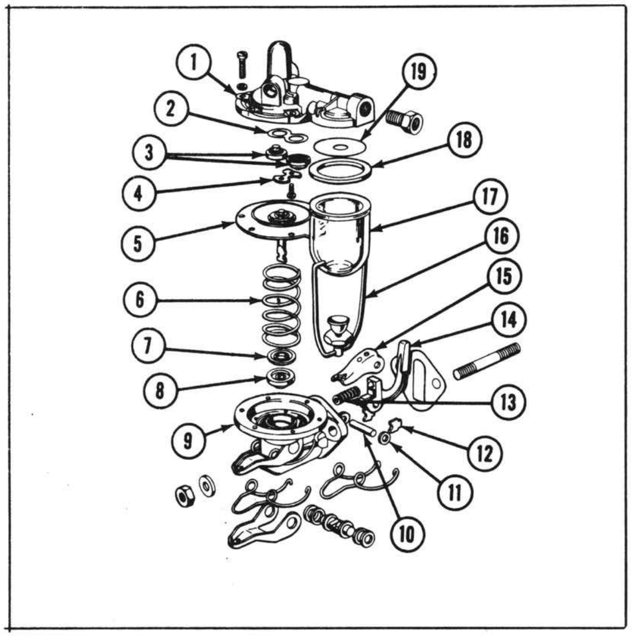

Fig. 7. Fuel Pump Nomenclature

1. Fuel pump housing assembly
2. Gasket – Valve to housing
3. Valves – Inlet and Outlet
4. Valve retainer
5. Lift pump diaphragm
6. Diaphragm return spring
7. Oil seal retainer
8. Pump body oil seal
9. Fuel pump body assembly
10. Pivot pin
11. Pivot pin washer
12. Pivot pin retainer
13. Rocker arm return spring
14. Rocker arm
15. Diaphragm operating lever
16. Bail assembly
17. Sediment bowl
18. Sediment bowl gasket
19. Fuel filter (screen)

and driven by an eccentric at the rear of the camshaft. The pump is equipped for hand priming.

In operation, as the camshaft revolves it lifts the pump rocker arm, No. 14, Fig. 7, which pulls the diaphragm, No. 5, Fig. 7, down against the return spring, No. 6, Fig. 7, thus creating a vacuum inside the pump. Fuel is drawn from the fuel tank through the sediment bowl, No. 17, Fig. 7, and filter, No. 19, Fig. 7, then through the inlet valve, No. 3, Fig. 7, into the pump chamber. On the return stroke, the return spring forces the diaphragm upwards, forcing fuel oil from the chamber through the outlet valve, No. 3, Fig. 7, to the primary and secondary fuel filters.

Fuel delivery is automatically regulated according to engine requirements.

TESTING THE FUEL PUMP

To check the operation of the fuel pump, make sure the fuel filters are not clogged and proceed as follows:

1. Disconnect the fuel outlet line from the fuel pump and install a pressure gauge.

2. Operate the hand priming lever several times, or turn the engine over with the starter and observe the fuel pressure reading.

3. Normal fuel pressure should be 5-8 psi. Replace or overhaul defective fuel pumps.

REMOVAL

To remove the fuel pump proceed as follows:

1. Close the fuel tank shut-off valve.

2. Remove the fuel inlet and outlet lines from fuel pump.

3. Remove the nuts securing the pump to the engine and remove pump from engine.

NOTE: To install the pump reverse the steps listed under removal. Make sure to use the proper gasket when installing the fuel pump. Incorrect thickness of gasket will affect operation of pump.

DISASSEMBLY AND SERVICING

Disassembly and servicing of the fuel pump will not be covered in this part. Refer to Group I, Section A - General Engine Servicing Procedures for further information.

FUEL FILTERS

CLEAN FUEL IS AN ABSOLUTE ESSENTIAL FOR DIESEL ENGINES.

Two fuel filters are used in conjunction with the 4A-203 engines and are shown in Fig. 8. Both filters use replaceable "throw away" paper type elements.

Make sure to caution the operator that the primary fuel filter be drained at least every 100 hours and that both filter elements be replaced at their specified hourly intervals. Replace the primary fuel filter element every 500 hours and the secondary fuel filter element every 1,000 hours.

In operation, the fuel that is delivered under low pressure by the fuel pump passes through the primary fuel filter, No. 2, Fig. 8, and the secondary fuel filter, No. 1, Fig. 8, to the injection pump. Excess fuel from the injection pump is returned to a chamber under the head

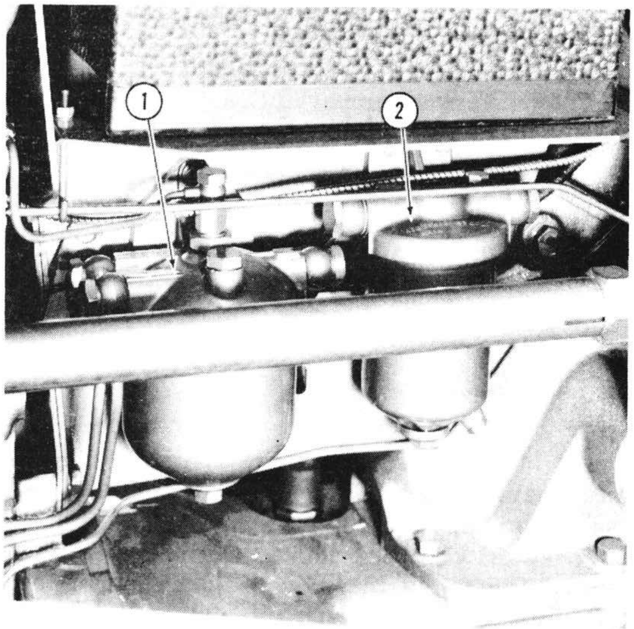

Fig. 8. Fuel Filters

1. Secondary fuel filter 2. Primary fuel filter

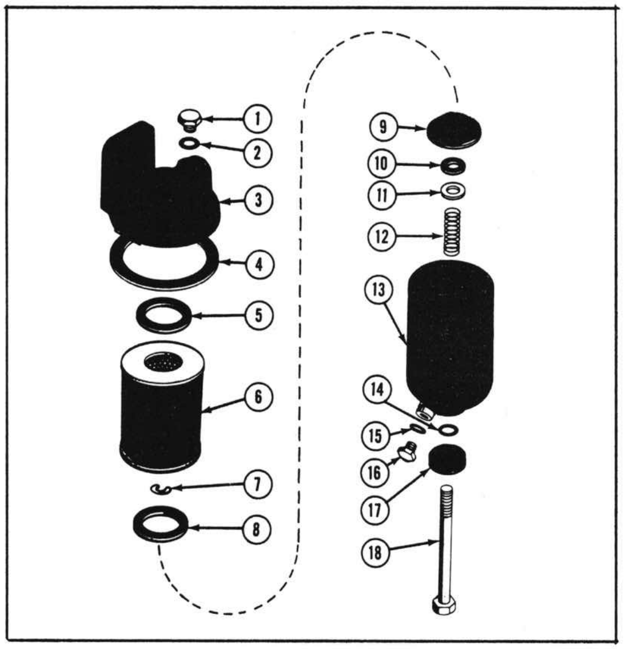

Fig. 9. Primary Fuel Filter Nomenclature and Sequence of Parts

1. Vent plug
2. Vent plug washer
3. Filter head assembly
4. Gasket – body to head
5. Gasket – Element end
6. Fuel filter element
7. Snap ring
8. Gasket – element end
9. Element lower plate
10. Element plate oil seal
11. Spring washer
12. Element tension spring
13. Filter body assembly
14. Body oil seal
15. Drain plug washer
16. Drain plug
17. Oil seal retainer
18. Center bolt

of the secondary fuel filter. When the engine is running, fuel is delivered from this chamber to the reservoir tank, which provides a permanent leak-back to the main fuel tank.

REPLACING THE FUEL FILTER ELEMENTS

Before changing the fuel filter elements, carefully clean the outside of the filter assemblies and turn off the supply of fuel to the filters, then proceed as follows:

> *IMPORTANT: Do not install substitute fuel filter elements. Use only genuine M-F fuel filter elements.*

Primary Fuel Filter

1. Loosen the vent plug, No. 1, Fig. 9, and drain plug, No. 16, Fig. 9, to allow the fuel to drain from the filter bowl.

2. Remove the center bolt, No. 18, Fig. 9, and remove the filter bowl, No. 13, Fig. 9.

3. Remove and discard the old filter element.

4. Thoroughly clean the filter bowl.

5. Refer to Fig. 9 for proper sequence of parts and install the new element into the filter bowl.

6. Using new gaskets, connect the bowl to the filter head with the center bolt. DO NOT OVER-TIGHTEN THE CENTER BOLT.

7. Open the fuel shut-off valve and prime the system as outlined on Page 3.

Secondary Fuel Filter

1. Loosen the vent plug, No. 2, Fig. 10, and drain plug, No. 16, Fig. 10, to allow the fuel to drain from the filter bowl.

2. Remove the bolt securing the leak-off line to the secondary filter. (Bolt not shown).

3. Loosen the center bolt and check valve assembly, No. 1, Fig. 10, and remove the filter bowl, No. 14, Fig. 10.

4. Remove and discard the filter element.

5. Thoroughly clean the filter bowl.

> *NOTE: Use new gaskets to prevent fuel leakage. For proper sequence of parts, see Fig. 10.*

6. Install the new element into the filter bowl and connect the bowl to the filter head.

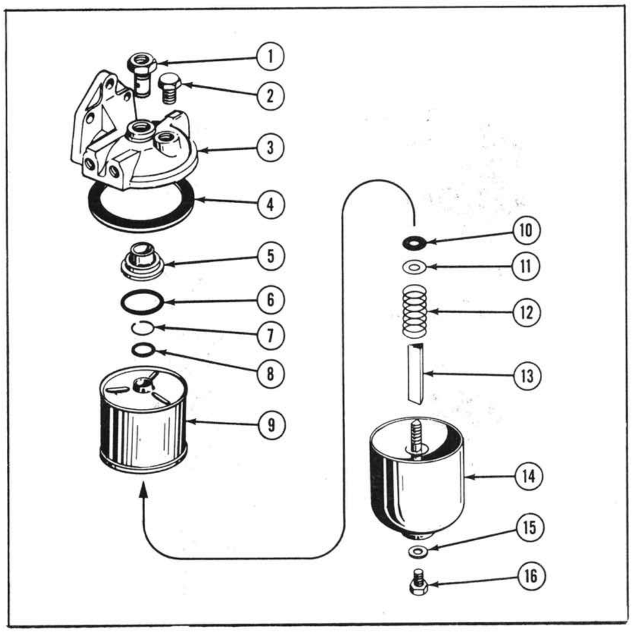

Fig. 10. Secondary Fuel Filter Nomenclature (Early Type)

1. Center bolt and check valve assembly
2. Vent plug
3. Filter head
4. Gasket – body to head
5. Element hold down collar
6. Collar "O" ring
7. Snap ring
8. Upper element sealing "O" ring
9. Fuel filter element
10. Lower element sealing "O" ring
11. Spring centering washer
12. Element tension spring
13. Element centering sleeve
14. Filter bowl
15. Drain plug washer
16. Drain plug

7. Reconnect the leak-off line, open the fuel shut-off valve and prime the system as outlined on Page 3.

> *NOTE: Later model engines are equipped with a different type secondary fuel filter as shown in Fig. 11. Replace this type of filter element every 1000 hours.*

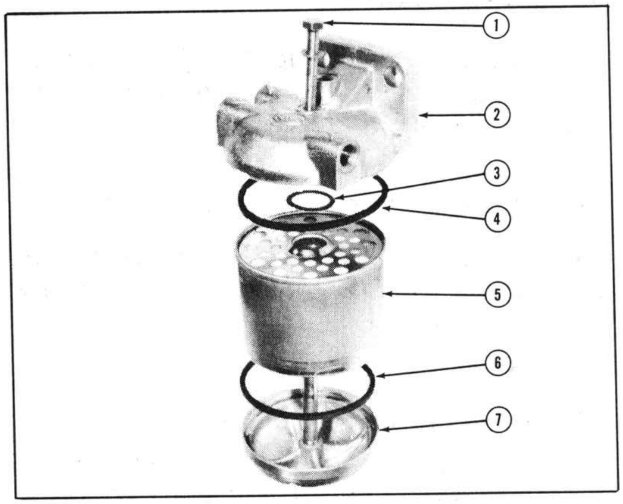

Fig. 11. Secondary Fuel Filter Nomenclature (Current Type)

1. Filter head bolt and washer
2. Filter head
3. Element seal
4. Top element seal
5. Filter element
6. Element seal
7. Filter base assembly

FUEL INJECTION PUMP

Four different numbered C.A.V. fuel injection pumps have been used in conjunction with the 4A-203 engine and are listed as follows:

1. DPA 3242656
2. DPA 3242657
3. DPA 3242697
4. DPA 3242698

All of the above pumps are completely interchangeable and are of the DPA distributor type as shown in Fig. 12, incorporating a built in mechanical governor with an automatic advance unit. The injection pump is flange mounted to the injection pump support and bolted to the timing gear housing. The pump is driven by the upper camshaft idler gear.

The fuel is pumped by a single element, and the fuel charges are distributed in the correct firing order and at the proper timing intervals to each cylinder by means of a rotary distributor integral with the pump. As a result, equal amounts of fuel delivery to each injector is an inherent feature of the pump and deliveries are not subject to maladjustment from one injector to another.

Accurate phasing is also a feature of the pump, as the timing intervals between injection strokes are determined by the accurate spacing of distribution ports and the high precision operating cams and are therefore, not subject to adjustment.

The pump is a compact, oil tight unit, completely lubricated by fuel oil and requires no additional lubrication. Sensitive speed control is maintained by a governor of the mechanical fly-weight operated type, which is incorporated in the pump.

Automatic variation of the start of injection is obtained with an automatic advance unit.

REMOVAL

To remove the fuel injection pump, THOROUGHLY CLEAN THE ENGINE and proceed as follows:

> *IMPORTANT: Before removing the injection pump for servicing, make*

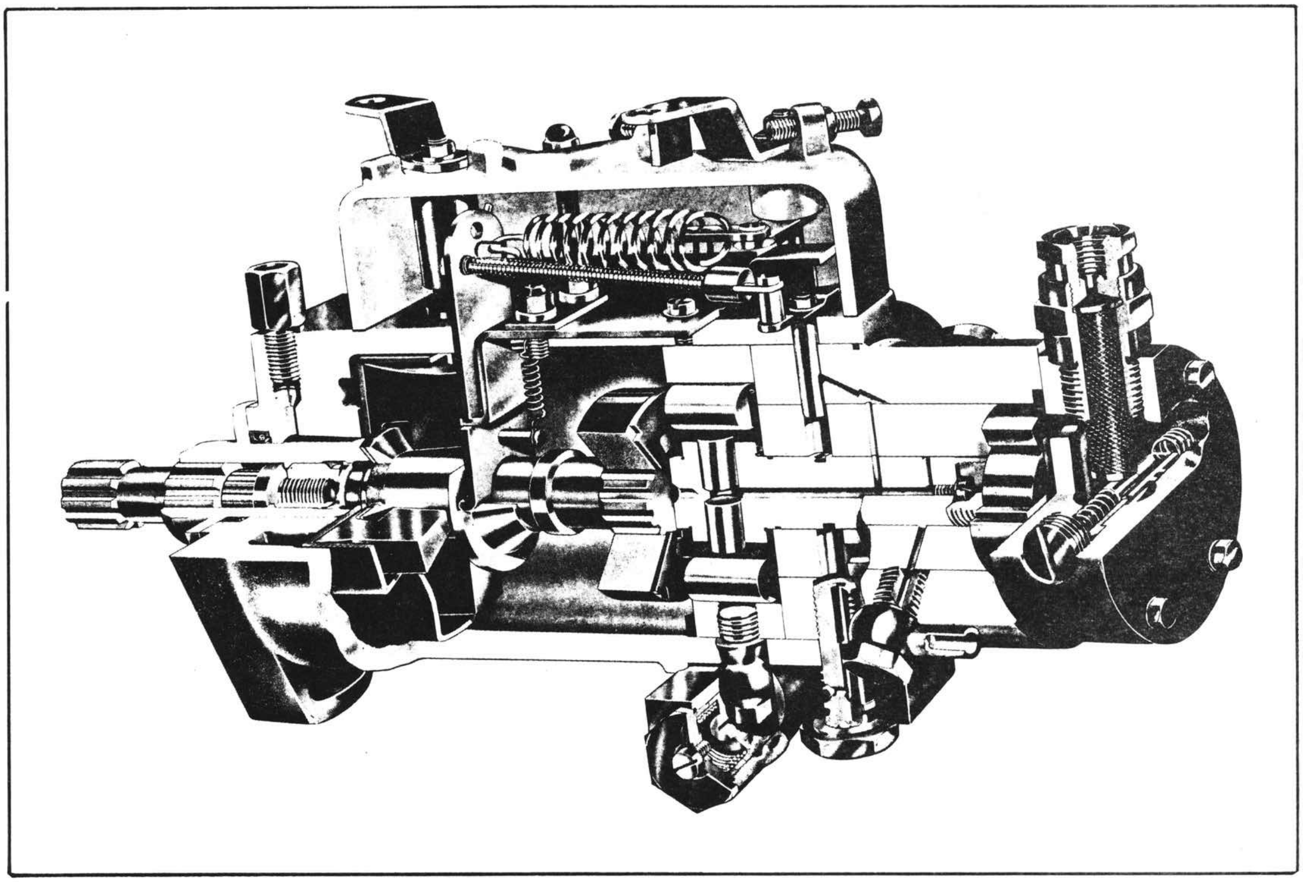

Fig. 12. C.A.V. "DPA" Distributor Type Fuel Injection Pump

sure that the injection pump really is at fault and that the difficulty is not caused by some other part of the fuel system.

1. Disconnect all linkage to the injection pump.

2. Remove the following parts:

a. All high pressure fuel lines from injection pump to injectors.

b. The low pressure fuel lines (fuel supply and return line) between secondary fuel filter and injection pump.

NOTE: Cap or otherwise cover all open fuel lines and ports to prevent dirt from entering into the fuel system.

c. Capscrews securing the injection pump to timing gear housing.

3. Carefully withdraw the injection pump and quill shaft from the timing gear housing. Make sure to cap or otherwise cover all fuel line openings.

IMPORTANT: DO NOT DISASSEMBLE THE INJECTION PUMP. Send faulty injection pumps to your nearest authorized C.A.V. service station for repair. If the seals are broken on the pump any warranty will become void.

INSTALLATION

To install the injection pump, proceed as follows:

1. Align the master spline, No. 2, Fig. 13, on the quill shaft with the corresponding spline on the adapter and position the injection pump in place, see Fig. 13.

2. Install the capscrews that secure the pump in position and rotate the pump so that the timing marks, No. 1, Fig. 13, on the pump body and pump support align, then, tighten the capscrews securely.

3. Install the low pressure fuel lines (fuel supply and return line) between the secondary fuel filter and the injection pump. Also, install all high pressure fuel lines from injection pump to injectors.

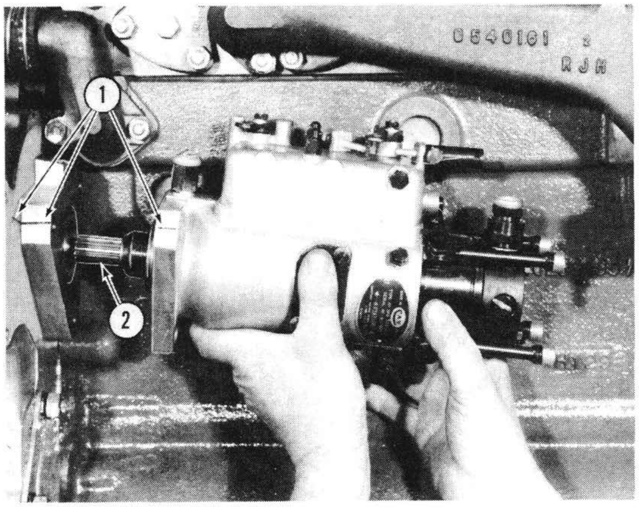

Fig. 13. Installing The Injection Pump

1. Timing marks 2. Master spline

IMPORTANT: When connecting the fuel lines, make sure that they are not under stress. Fuel line stress will cause premature line breakage.

4. Connect the fuel shut-off and throttle control rods.

5. Check injection pump timing and adjust it if necessary, then prime the fuel system.

INJECTION PUMP TIMING

The quill shaft connecting the injection pump gear adapter to the injection pump has a master spline, No. 2, Fig. 13, that will allow it to be installed in only one position. As long as the injection pump gear and adapter is properly timed to the other timing gears, the injection pump may be removed and reinstalled without regard to the location of the crankshaft and the timing marks on the flywheel and injection pump rotor.

Whenever a new injection pump, pump gear or adapter is installed, or when incorrect pump timing is suspected the timing must be checked as follows:

Checking Timing

To check the injection pump timing, proceed as follows:

1. Remove the plug from the inspection hole in the transmission housing.

2. Break the seal and remove the inspection cover from the side of the injection pump.

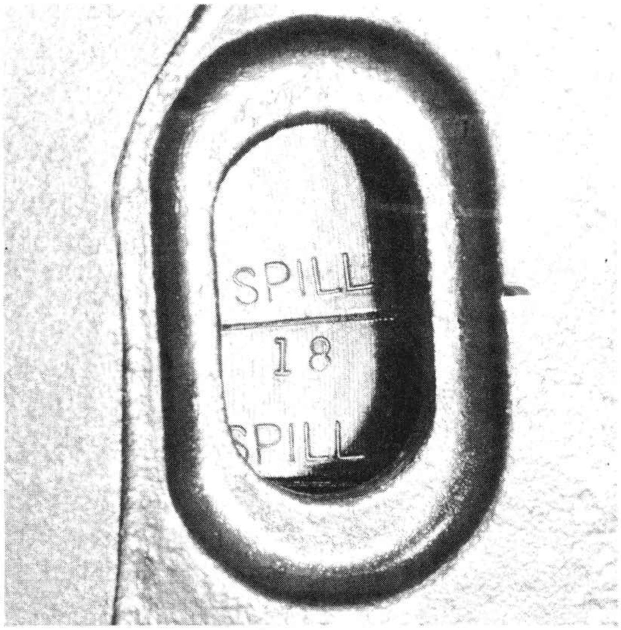

Fig. 14. Flywheel Timing Mark Aligned with Inspection Hole Mark

NOTE: Reseal the inspection cover after reassembly.

3. Turn the crankshaft back 90 degrees and then slowly turn it forward in the direction of normal rotation until No. 1 piston is coming up on compression stroke and the spill 18 or the spill 20 mark on the front face of the flywheel appears in the middle of the inspection hole as shown in Fig. 14.

NOTE: Early model engines are equipped with flywheels marked spill 18 and spill 23. Fuel injection pumps on these engines must be timed to SPILL 18.

Later model engines have flywheels marked spill 20, fuel injection pumps on these engines must be timed to spill 20.

4. With the crankshaft positioned at 18 degrees or 20 degrees B.T.D.C., the scribe line marked "C" on the rotor of the injection pump must align with the scribe line across the lower eye of the snap ring fixed in the pump body. See Fig. 15.

Adjusting Timing

If after checking the pump timing the scribe line marked "C" does not align with scribe line on snap ring, make sure that the timing marks, No. 1, Fig. 13, on pump body and pump support are aligned, then proceed as follows:

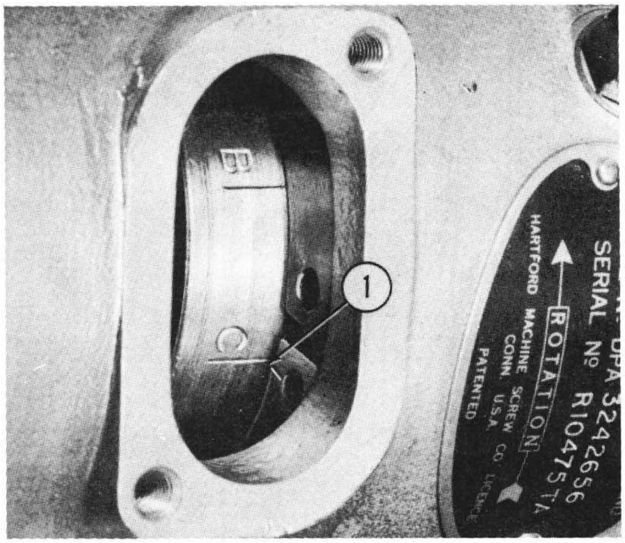

Fig. 15. Injection Pump with Timing Cover Removed

1. Rotor and snap ring lines properly aligned

1. Remove the oil filler cover from the front of the timing gear cover.

2. Loosen the three cap screws securing the injection pump gear, No. 1, Fig. 16, and adapter, No. 2, Fig. 16.

3. With the bolts loosened, turn the adapter and hub in the required direction to bring the scribe line marked "C" into alignment with the scribe line on the snap ring as shown in Fig. 15.

4. After adjusting, tighten the adapter bolts securely and scribe new timing marks on the gear and adapter as shown by No. 3, Fig. 16, then replace the oil filler cover and inspection covers.

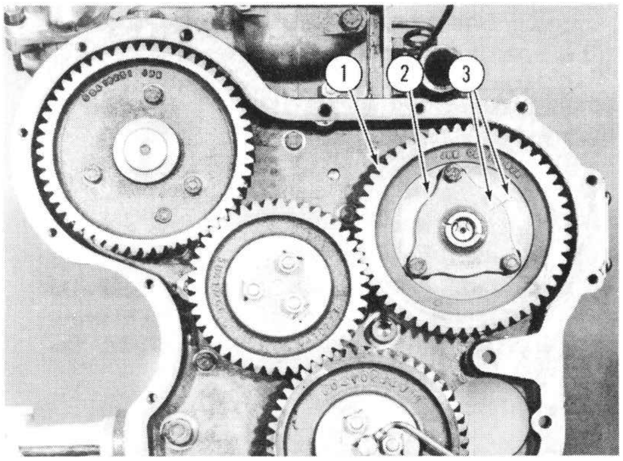

Fig. 16. Nomenclature

1. Injection pump gear 2. Injection pump gear adapter
3. Adapter and gear timing marks

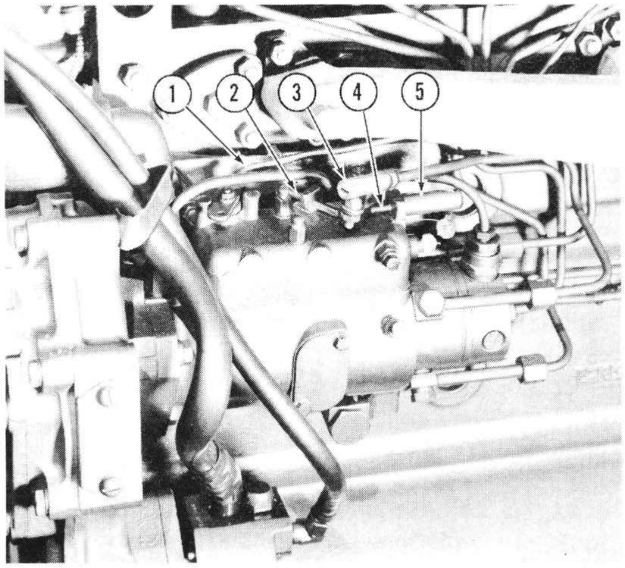

Fig. 17. Injection Pump Nomenclature

1. Fuel shut-off control rod
2. Low idle speed adjustment screw
3. Throttle control rod
4. High idle speed adjustment
5. Adjusting screw cover sleeve

ADJUSTING ENGINE SPEED

The fuel injection pump is provided with a low idle speed adjustment screw, No. 2, Fig. 17, and a high idle speed adjustment screw, No. 4, Fig. 17, to provide a means of regulating the engine speed within the proper limits.

The correct crankshaft speeds for the 4A-203 engine are listed as follows:

Low idle speed	500-550 RPM (PTO speed of 180-198 RPM)
Rated engine speed	2000-2050 RPM (PTO speed of 720-738 RPM)
High idle speed (no load)	2100-2150 RPM (PTO speed of 756-774 RPM)

> *IMPORTANT: The high idle speed adjustment screw is factory adjusted and sealed. IF THE ENGINE AND/OR INJECTION PUMP IS STILL WITHIN WARRANTY, DO NOT BREAK THE SEAL AND ATTEMPT TO ADJUST THE HIGH IDLE SPEED. Send the injection pump to your nearest authorized C.A.V. service station, or contact your Branch Service Supervisor for possible permission and instructions on adjusting the high idle speed. BREAKING THE SEAL WILL VOID WARRANTY.*

Check the throttle linkage before adjusting the engine speed, to make sure it is properly adjusted and not bent or damaged so that it restricts the full travel of the throttle lever on the injection pump.

Adjusting Low Idle Speed

1. Start the engine and allow it to reach normal operating temperature.

2. Position the hand throttle lever to the low idle position and check the idle speed with an accurate tachometer.

3. To adjust the low idle speed, loosen the lock nut and turn the adjusting screw, No. 2, Fig. 17, in to increase speed, or out to decrease speed. Retighten the lock nut after adjusting speed.

Adjusting High Idle Speed

1. With the engine running at normal operating temperature, position the throttle lever to the "wide open" position and check the engine speed with an accurate tachometer.

2. To adjust the high idle speed (no load), break the seal and remove the cover sleeve, No. 5, Fig. 17. Loosen the lock nut and turn the adjusting screw, No. 4, Fig. 17, out to increase speed or in to decrease speed. DO NOT SET THE ENGINE SPEED HIGHER THAN 2150 RPM. Retighten the lock nut after adjusting the engine speed, then install and reseal the cover sleeve.

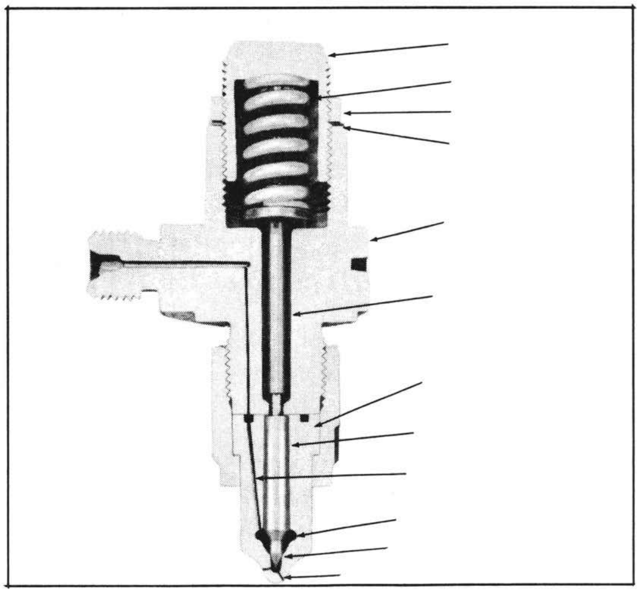

Fig. 18. Cutaway View of Injector

1. Adjusting screw	7. Nozzle body
2. Pressure spring	8. Nozzle valve
3. Cap lock nut	9. Fuel feed hole
4. Washer – nut to body	10. Fuel gallery
5. Nozzle holder	11. Valve seat
6. Spring guide spindle	12. Fuel spray hole

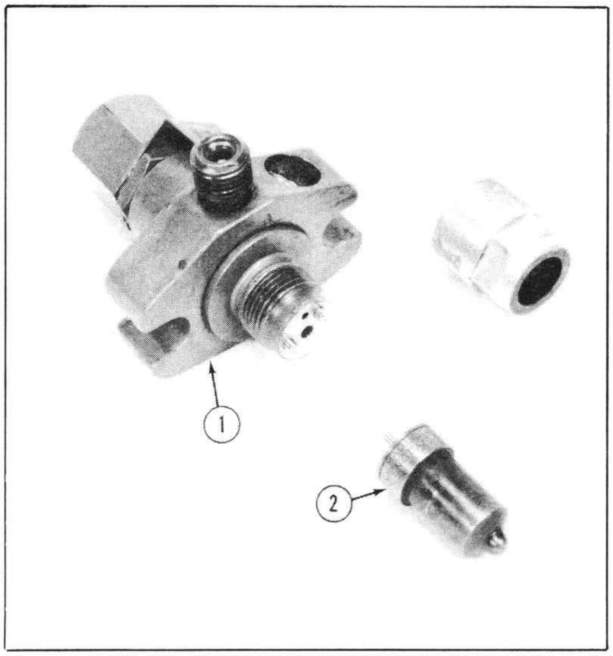

Fig. 19. Each Injector Consists of Two Main Parts

1. Nozzle holder 2. Nozzle

FUEL INJECTORS

The 4A-203 engine is equipped with C.A.V. injectors which direct fuel into the engine in two fine sprays. One fuel spray is directed into the combustion chamber and the other into the cylinder itself, see No. 12, Fig. 18.

Each injector consists of two main parts: The nozzle holder and the nozzle, as shown in Fig. 19.

> *IMPORTANT: Each nozzle consists of two parts: The nozzle body, No. 2, Fig. 20, and the nozzle valve, No. 1, Fig. 20. Both of these parts are mated and cannot be replaced individually. If one or the other requires replacement, a complete new nozzle must be installed.*

The C.A.V. nozzle holder and nozzle identification numbers are as follows:

Nozzle holder . . . . BKB 32SD5085
Nozzle . . . . BDL 110S6133

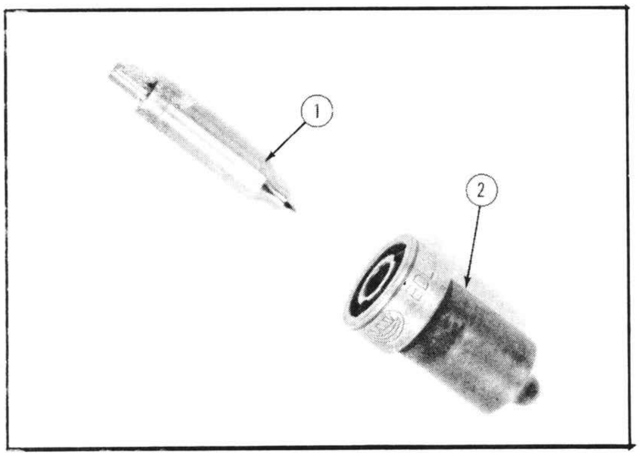

Fig. 20. The Nozzle Consists of Two Mated Parts

1. Nozzle Valve 2. Nozzle Body

REMOVAL

To remove the fuel injectors from the cylinder head, refer to Fig. 21, and proceed as follows:

1. Carefully clean the engine and fuel lines. THIS IS VERY IMPORTANT.

2. Loosen the high pressure fuel line connections at both the injector and the injection pump ends.

3. After loosening the connections, disconnect the high pressure and low pressure leak-off fuel lines and connections from the injectors.

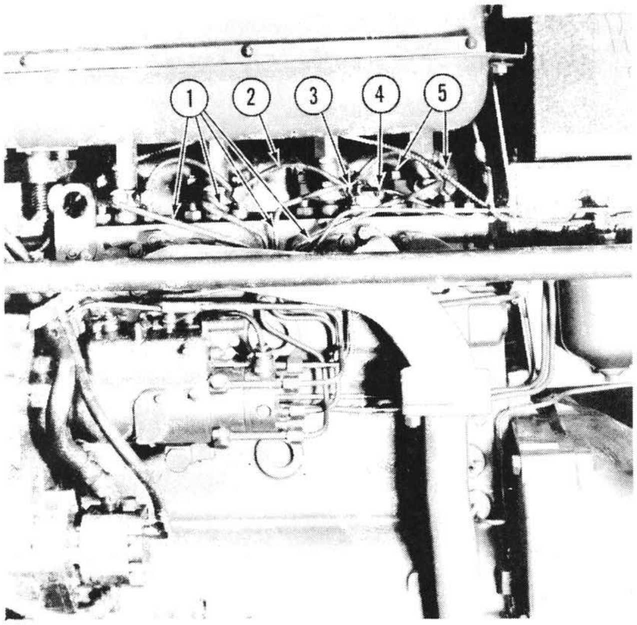

Fig. 21. Nomenclature

1. High pressure fuel lines 3. Leak-off Line connection
2. Leak-off line 4. Line assembly leak-off, tee to injector
5. Injector clamp nuts

IMPORTANT: Cap or otherwise cover all open fuel line fittings and connections. Also, DO NOT BEND THE FUEL LINES WHEN REMOVING THE INJECTORS.

4. Remove the injector clamp nuts and CAREFULLY remove the injectors from the cylinder head.

5. Make sure the old injector washers (gaskets) are removed from the cylinder head.

INSTALLATION

To install the injectors, proceed as follows:

1. Carefully clean each nozzle recess in the cylinder head. Use a piece of wood dowel or brass stock properly shaped to clean the recess.

NOTE: Do not use hard sharp tools that would scratch the sealing surfaces.

2. Blow out all carbon and foreign material from each recess. MAKE SURE ALL RECESSES ARE THOROUGHLY CLEANED.

3. Make sure the old injector washers (copper gaskets) have been removed and install a new washer in each recess.

4. Carefully install each injector into its recess and using a torque wrench tighten the clamp nuts EVENLY TO 21-24 FT.-LBS. TORQUE. BE CAREFUL NOT TO COCK THE INJECTOR IN THE CYLINDER HEAD.

5. Before reconnecting the high pressure fuel lines to the injectors, crank the engine with the starter to flush out the lines.

6. Reconnect the high pressure and low pressure leak-off fuel lines to the injectors and carefully tighten the connections. THE PROPER TORQUE ON THE BANJO-TYPE LEAK-OFF BOLTS IS 5-7 FT.-LBS.

NOTE: When reconnecting the high pressure fuel lines, make sure the lines are not under stress, if necessary, slightly bend the line to remove any stress that is present. Also, do not overtighten the fuel lines.

7. Start the engine, then inspect for leaking fuel lines and blow-by past the nozzle holder.

FUEL INJECTOR TROUBLE SHOOTING

Symptoms of a Faulty Injector

The first symptoms of injector difficulties usually fall under one or more of the following headings:

1. Knocking in one or more cylinders.
2. Erratic engine operation.
3. Engine overheating.
4. Loss of power.
5. Smoky exhaust (black).
6. Increased fuel consumption.

Do not automatically assume, however, that the injectors are the cause of the trouble, because water, air, or dirt in the fuel, clogged fuel filters, air cleaner, low engine operating temperature, incorrect injection pump or engine valve timing and other factors may cause the same symptoms.

Locating a Faulty Injector

If the engine does not run properly and the symptoms indicate a faulty injector, the faulty injector may be located as follows:

1. Start the engine and bring it to normal operating temperature.

2. Position the throttle lever in the idling position.

3. Loosen each high pressure fuel line (one at a time) at the injector end while the engine is running. The loosened connection will allow the fuel to escape before reaching the injector and will ''cut-out'' that particular injector. The cylinder that is least affecting engine performance usually is the one with the faulty injector.

> *NOTE: In instances where it is difficult to detect a faulty injector, use an accurate tachometer and check both low and high idle speeds with the suspected injector ''cut-out''. The injector that least affects the engine speed is usually the faulty one.*

4. After performing step #3, remove the suspected injector and test it with a dependable nozzle tester for the following:

   a. Opening pressure.

   b. Valve seat leakage.

   c. Spray pattern.

   d. Back leakage.

Common Injector Difficulties

Common fuel injector difficulties with their causes and remedies are listed as follows:

1. Poor Spray Pattern
   - a. Nozzle body tip badly carboned, or damaged - clean or replace nozzle.
   - b. Spray holes partially blocked or eroded - clean or replace nozzle.
2. Leakage or ''Dribble'' from the Spray Holes
   - a. Dirty or damaged nozzle valve and/or nozzle body seat - clean thoroughly, if leakage continues replace nozzle.
   - b. Nozzle valve sticking - disassemble and clean nozzle.
3. Excess Fuel Leakage at Leak-Off Connection
   - a. Lapped surfaces of nozzle valve and nozzle body worn or damaged - install new nozzle.
   - b. Internal fuel leakage past the pressure faces of the nozzle holder and nozzle body - disassemble and carefully clean pressure faces.
4. Fuel Leakage Between Pressure Faces of Nozzle Holder and Nozzle
   - a. Dirty or damaged pressure faces - THOROUGHLY clean the pressure faces. If the pressure faces are scratched or otherwise damaged, install a new injector.
   - b. Cap nut not tight - tighten to 50 ft.-lbs. torque.

SERVICING THE INJECTORS

Nozzle Testing

The main requirements of a good nozzle are as follows:

A. Correct valve opening pressure.

B. Pressure tight seats.

C. Good atomization and spray pattern.

D. Freedom from excessive back leakage.

> *IMPORTANT: Before attempting to test a nozzle, make sure you have a dependable nozzle tester and the necessary connectors. Also, USE ONLY CLEAN APPROVED TESTING OIL IN THE TESTER TANK.*

INJECTORS MUST BE TESTED WHEN PERFORMING THE FOLLOWING OPERATIONS:

1. When performing a complete engine overhaul.

2. When an injector is suspected of being faulty.

3. When an injector has been disassembled and serviced, prior to its reinstallation.

4. When replacing injectors or installing new nozzles, injectors must be cleaned and tested prior to installation in the engine.

TO TEST THE NOZZLES, PROCEED AS FOLLOWS:

To simplify the instructions, the test stand described in the following test procedure is the Bacharach only, see Fig. 22. Except for description and location of outlets, the instructions will generally apply to all nozzle testers.

1. Throughly clean the connector tube, then connect it to the lower outlet on the test stand and pump clean oil through it to flush out the tube.

> *NOTE: Practice extreme cleanliness, to avoid pumping dirt into the injector.*

2. Remove the injector cap, No. 1, Fig. 23, and connect the injector to the connector tube.

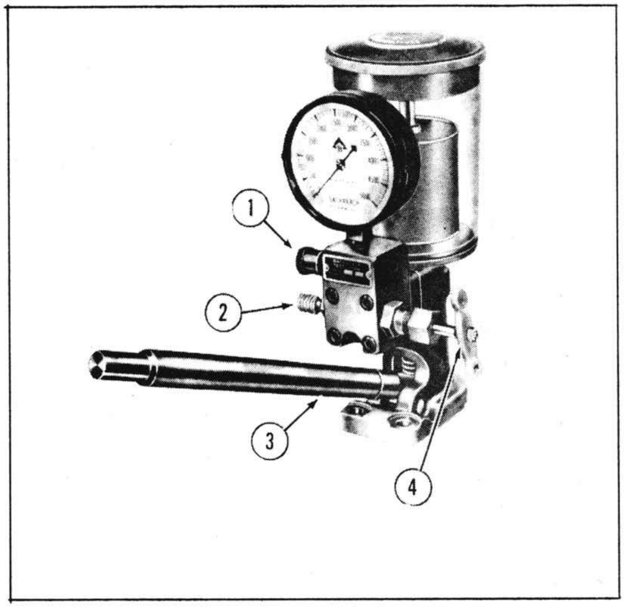

Fig. 22. Bacharach Injector Test Stand

1. Upper outlet
2. Lower outlet
3. Hand lever
4. Pressure gauge valve handle

3. Close the pressure gauge valve (to avoid amaging it) and operate the hand lever rapidly for at least 10 long strokes to clear all air from the injector.

> ***CAUTION: Do not allow the fuel spray from the nozzle to come in contact with the body. The spray has sufficient pressure to puncture the skin and should the fuel enter the blood stream, it may cause blood poisoning.***

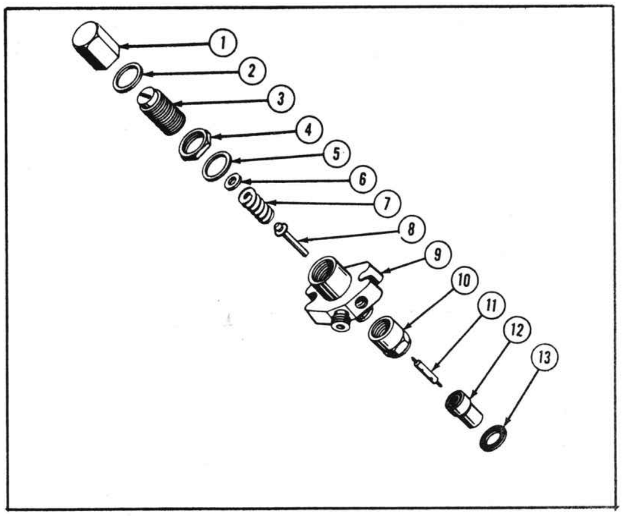

Fig. 23. Injector Nomenclature and Sequence of Parts

1. Injector cap
2. Washer – cap to nut (top)
3. Adjusting screw
4. Cap lock nut
5. Washer – nut to body (bottom)
6. Pressure spring washer
7. Pressure spring
8. Spring guide spindle
9. Nozzle holder
10. Nozzle cap nut
11. Nozzle valve
12. Nozzle body
13. Atomizer washer

TESTING FOR OPENING PRESSURE

4. Open the pressure gauge valve and operate the hand lever slowly until sufficient pressure is developed to lift the nozzle valve and spray the fuel. Observe the opening pressure as indicated on the pressure gauge.

5. Opening pressure on used injectors (more than 25 hours of operation) should be 1760 PSI. New injectors should have an opening pressure of 1980 PSI to allow the spring to "settle in". If the nozzle valve does not lift at the appropriate pressure as given above, loosen the lock nut, No. 4, Fig. 23, and turn the adjusting screw, No. 3, Fig. 23, (turn in to increase pressure, or out to decrease pressure) until the correct opening pressure is obtained.

> *NOTE: Always recheck the opening pressure after retightening the lock nut to make sure the pressure setting is not altered.*

TESTING FOR VALVE SEAT LEAKAGE

6. A used injector set at 1760 PSI opening pressure must not leak at 1610 PSI. A new injector set at 1980 PSI opening pressure must not leak at 1730 PSI.

To test new or used injectors for valve leakage, wipe the tip of the nozzle body, No. 12, Fig. 23, and slowly build up the pressure to 150 PSI LESS THAN THE OPENING PRESSURE SETTING, then hold this pressure for 10 seconds and observe the nozzle tip for leakage. If drops of fuel collect at this pressure, the nozzle valve is not seating properly and must be serviced and retested. A slight amount of dampness may be disregarded.

TESTING FOR SPRAY PATTERN

7. Close the pressure gauge valve, then operate the hand lever at a speed of 90-100 strokes per minute and observe the nozzle spray pattern. Two symmetrical sprays should come from the tip of the nozzle body. Each spray pattern should be completely atomized spreading to approximately three inches in diameter at about one foot away from the nozzle tip. If the spray patterns do not have equal penetration into the air, are ragged, unduly wet, streaky or not symmetrical, the nozzle must be serviced and retested.

BACK LEAKAGE (LEAKAGE PAST THE NOZZLE VALVE AND BODY)

8. A very small amount of back leakage is necessary for the lubrication of the nozzle valve and body. However, excessive back leakage caused by a worn or scored nozzle valve and/or body will affect the operation of the engine and must be corrected by installing a new nozzle.

To determine what is an excessive amount of back leakage, proceed as follows:

a. Connect the injector to the upper outlet on the test stand and open the pressure gauge valve.

b. Operate the hand lever to clear all air from the injector.

c. Set the nozzle opening pressure at 2350-2500 PSI.

d. Pump up the pressure to just below the opening pressure, then close the pressure gauge valve and time the pressure drop from 2200 PSI to 1470 PSI. For a nozzle in good condition, this time must not be less than 6 seconds when using a DEPENDABLE TEST OIL at a temperature of 50-70°F. At higher temperatures, a period of time slightly less than 6 seconds may be considered satisfactory. REPLACE NOZZLES THAT DO NOT MEET THESE SPECIFICATIONS. Be sure to reset serviceable injectors to their proper opening pressure after making this test.

> *IMPORTANT: When making this test, make sure that there is no leakage at the connections or the pressure faces of the nozzle holder (Fig. 24) and nozzle body (Fig. 25) as any leakage of this type will cause erroneous test readings. LEAKAGE PAST THE PRESSURE FACES MAY BE EITHER EXTERNAL OR INTERNAL. External leakage may be easily observed; however, internal leakage cannot easily be distinguished from back leakage past the nozzle valve and body.*
>
> *If external leakage is apparent, or if internal leakage is suspected, do not attempt over-tightening the cap nut to stop such leakage. To correct the leakage, remove the nozzle and care-*

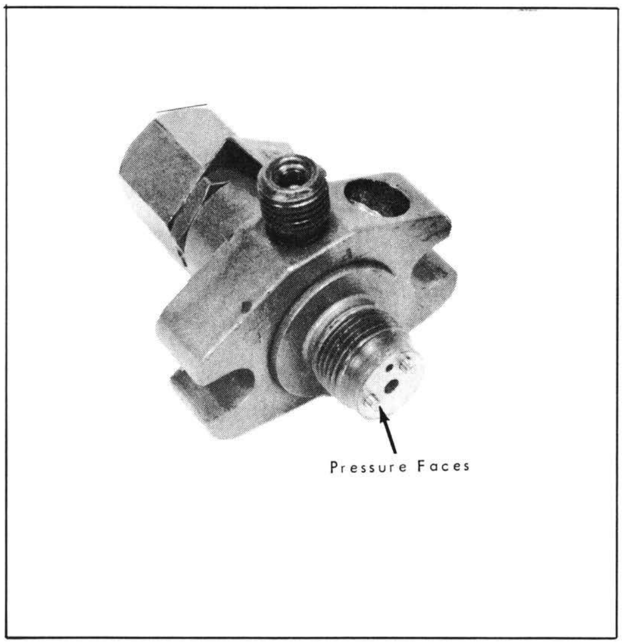

Fig. 24. Pressure Face on Nozzle Holder

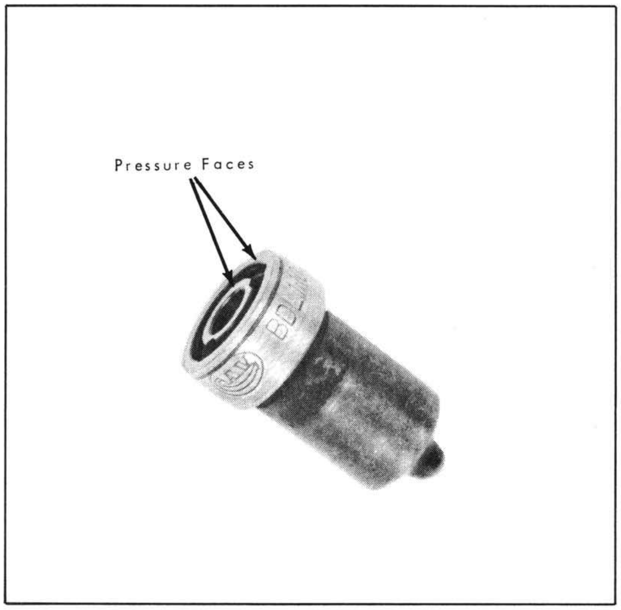

Fig. 25. Pressure Faces on Nozzle Body

fully examine the pressure faces to determine if they are dirty, scratched, or otherwise damaged. If the pressure faces are not damaged, carefully clean them, then reassemble the injector and retest it. If the pressure drop time is still low, this indicates excessive back leakage.

9. If the injector passes the opening pressure, valve seat leakage, spray pattern and back leakage tests, reinstall the injector into the cylinder head. DO NOT DISASSEMBLE INJECTORS THAT PASS ALL OF THE TESTS.

Removing and Disassembling the Nozzle

To remove and disassemble the nozzle, proceed as follows:

IMPORTANT: Always check the operation of a fuel injector on a test stand before disassembling it. If the injector passes all of the tests, there is no need to disassemble or adjust it.

1. Remove the injector and carefully clean all dirt and loose carbon from the injector. CLEANLINESS IS EXTREMELY IMPORTANT AND CANNOT BE OVEREMPHASIZED.

2. Remove the injector cap, No. 1, Fig. 23, and loosen the cap lock nut, No. 4, Fig. 23, then turn the adjusting screw, No. 3, Fig. 23, out to release the spring pressure.

3. Remove the nozzle cap nut as shown in Fig. 26.

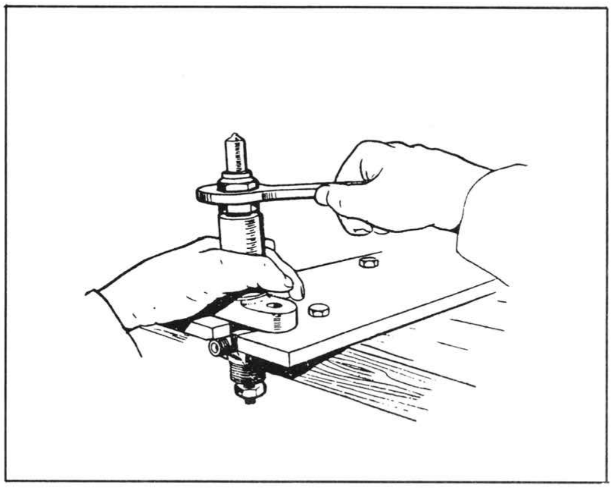

Fig. 26. Removing the Nozzle Cap Nut

4. Lift the nozzle assembly off the holder. REPLACE THE NOZZLE CAP NUT TO PROTECT THE LAPPED SURFACE OF THE NOZZLE HOLDER

5. Pull the nozzle valve, No. 11, Fig. 23, out of the nozzle body, No. 12, Fig. 23, WITH YOUR FINGERS. If the nozzle body is blued, or the seating area has a dull circumferential ring indicating that wear or pitting has taken place, the nozzle assembly should be replaced or sent to a C.A.V. service station for possible overhaul. Do not attempt under any circumstances to service it by lapping the nozzle body and valve.

IMPORTANT: If the nozzle valve is stuck in the nozzle body, DO NOT ATTEMPT TO PULL IT OUT WITH PLIERS.

REMOVING STUCK NOZZLE VALVES

To remove stuck nozzle valves, proceed as follows:

a. Soak the nozzle assembly in a suitable carbon solvent, then pull the valve out with your fingers.

c. Nozzles that cannot be disassembled after soaking in carbon solvent must be placed in a hydraulic nozzle valve extractor, see Fig. 27.

NOTE: The nozzle extractor uses hydraulic pressure developed by the nozzle test stand, to force the nozzle valve out of the body.

To use the nozzle extractor on a Bacharach test stand, proceed as follows:

1. Remove the N-1 connector tube and N-7 nut from the test stand.

2. Insert the stuck nozzle assembly in the nozzle extractor, as shown in Fig. 27.

3. Use N-4 nut and install the nozzle extractor on the test stand.

4. Operate the hand lever to build up pressure in the nozzle extractor and free the stuck nozzle valve.

NOTE: A free nozzle will be indicated by a sudden pressure drop on the pressure gauge.

If the nozzle valve cannot be freed by the pressure developed by the test stand, discard the nozzle assembly as the body and nozzle valve are probably scored.

Cleaning and Assembling the Injectors

1. Test the complete injector as outlined on Page 15 before disassembling it.
2. Remove the nozzle assembly from the injector, and remove the nozzle valve from the nozzle body as outlined on Page 17. KEEP COMPONENT PARTS OF INJECTORS SEPARATE TO PREVENT INTERCHANGING OF PARTS. THE NOZZLE VALVE AND BODY ARE MATED PARTS AND MUST NOT BE INTERCHANGED.

IMPORTANT: The nozzle must be free from all damage, and it is important that it is not "blued" due to overheating. All polished surfaces must be relatively bright without scratches or dull patches. Also, it is essential that the pressure surfaces on the nozzle holder and nozzle body are undamaged and clean, as these surfaces must register together to form a high pressure joint between the nozzle holder and nozzle. AVOID TOUCHING THE LAPPED SURFACES OF THE NOZZLE VALVES WITH YOUR HANDS. ACID AND MOISTURE FROM THE SKIN IS CORROSIVE AND CAN DAMAGE THE PRECISION SURFACES.

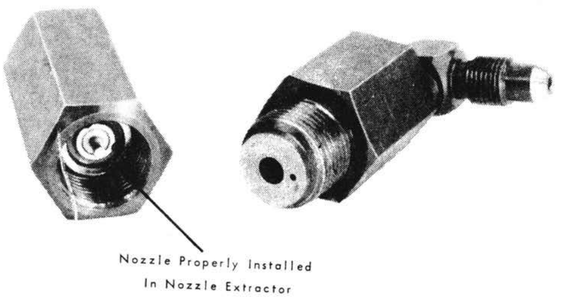

Fig. 27. Hydraulic Nozzle Valve Extractor

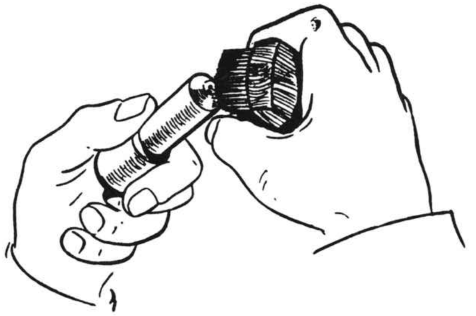

Fig. 28. Cleaning Outside of Nozzle Body

3. Brush all carbon from the outside of the nozzle body with a brass wire brush as shown in Fig. 28, then place body and valve in carbon solvent to soften the carbon.

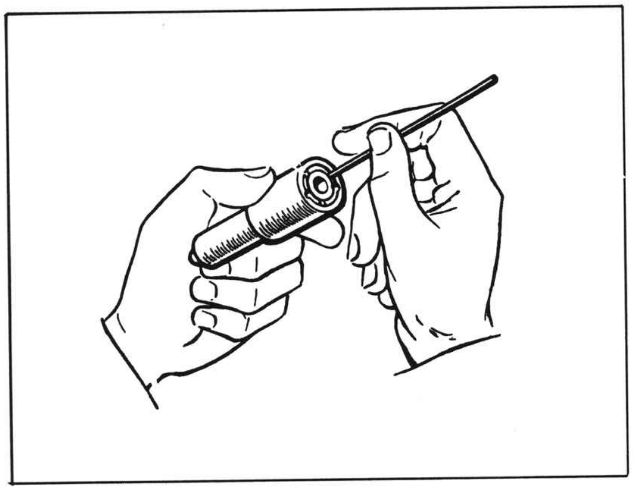

Fig. 29. Cleaning Fuel Feed Hole in Nozzle Body

4. Clean out the small feed channel bore in the nozzle body with the drill (size 0.061 inch) as shown in Fig. 29.

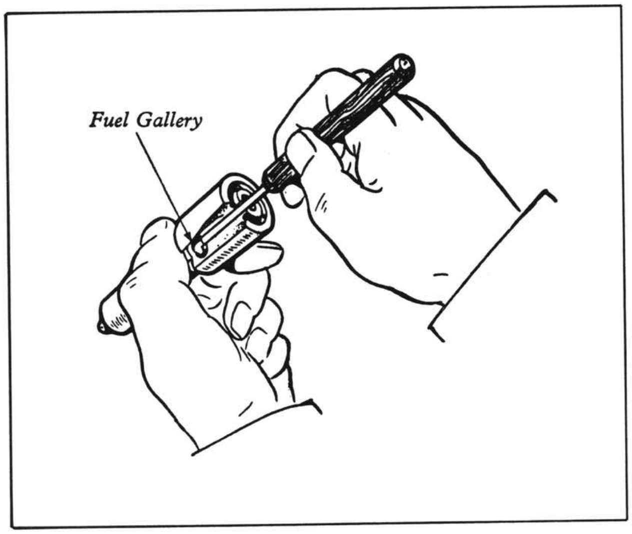

Fig. 30. Cleaning Fuel Gallery in Nozzle Body

5. Insert the special groove scraper into the nozzle body as shown in Fig. 30. Press hard against the side of the fuel gallery and rotate to clear all carbon deposits from this area.

6. Insert the seat scraper into the nozzle body and clean all carbon from the valve seat by rotating and pressing on the scraper as shown in Fig. 31.

7. Apply mutton tallow to a polishing stick and thoroughly clean the valve seat in the nozzle body as shown in Fig. 32.

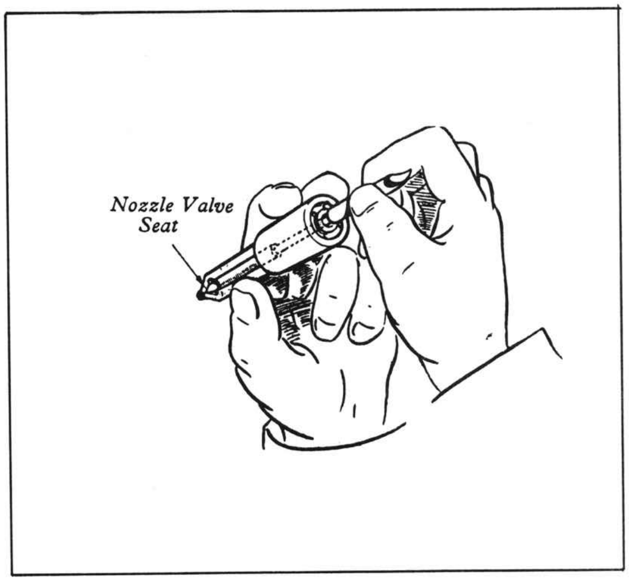

Fig. 31. Cleaning Valve Seat in Nozzle Body

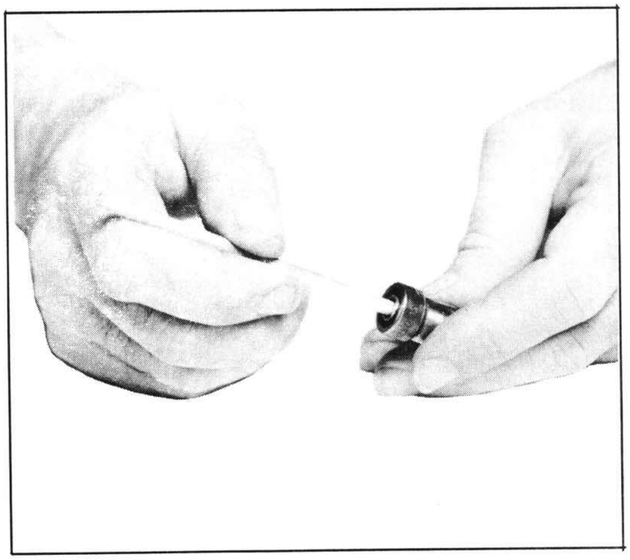

Fig. 32. Polishing Valve Seat in Nozzle Body

8. Using the probe tool with a 0.013 inch wire, thoroughly clean the two spray holes in the nozzle body as shown in Fig. 33.

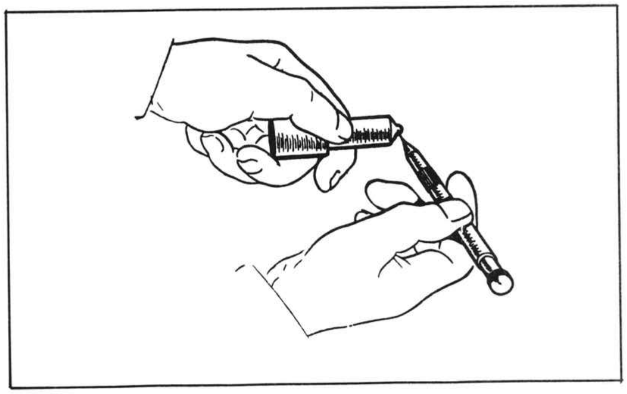

Fig. 33. Cleaning Fuel Spray Holes in Nozzle Body

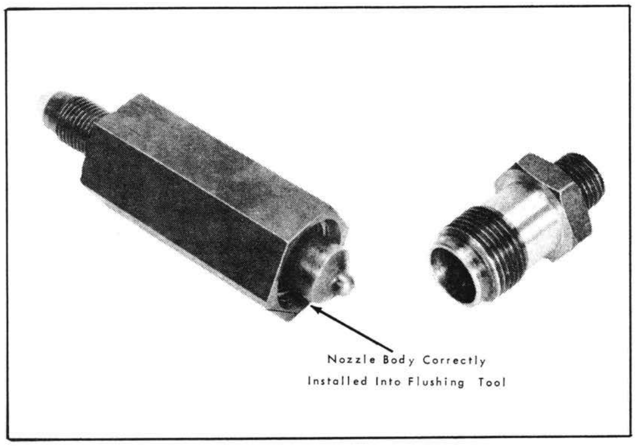

Fig. 34. Nozzle Body Flushing Tool

9. Install the nozzle body into the flushing tool as shown in Fig. 34, then connect the flushing tool to the test stand with the open end of the nozzle body downward as shown in Fig. 35. Pump the test stand lever rapidly to force the test oil through the nozzle body so that the spray holes, body cavity and nozzle body bores are thoroughly cleaned.

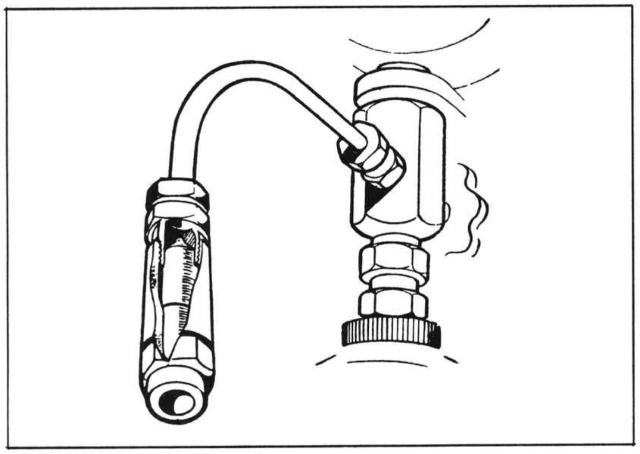

Fig. 35. Flushing Tool Correctly Installed to Clean Nozzle Body

10. Using a brass wire brush or a clean lint free cloth carefully clean all carbon and varnish deposits from the nozzle valve, see Fig. 36. Use extreme care as any burr or small scratch may cause valve seat leakage.

> *IMPORTANT: Hard or sharp tools, jewlers rouge, emery paper, grinding compounds or other abrasives must never be used to clean the nozzle valve, or any part of the nozzle assembly.*

If the nozzle valve does not clean up, or if it is nicked, scored, or shows any sign of damage a new nozzle assembly must be installed.

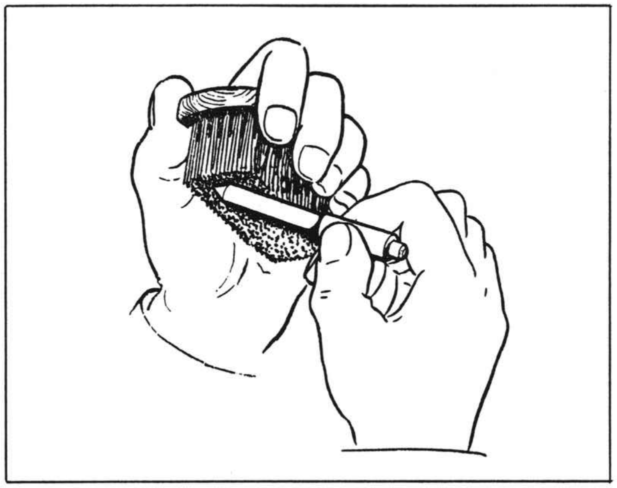

Fig. 36. Cleaning Nozzle Valve

11. After carefully cleaning the nozzle body and nozzle valve, place them in clean fuel oil. To prevent the closely lapped surfaces from being touched by the hands, install the valve into its mated body under the surface of the fuel oil.

> *NOTE: The nozzle valve must slide freely in its body. To make sure that the valve is free, hold the nozzle body at a 45 degree angle, then lift the valve approximately one third of its length out of the body and release it. THE VALVE SHOULD SLIDE DOWN INTO THE BODY BY ITS OWN WEIGHT.*
>
> *If the valve will not slide freely, thoroughly reclean the nozzle body and valve and recheck it. If necessary use mutton tallow and work the valve in its body to clean any carbon or varnish from inside the body. INSTALL A NEW NOZZLE ASSEMBLY, IF THE VALVE CANNOT BE MADE TO SLIDE FREELY.*

12. If the nozzle holder has been disassembled, all parts should be thoroughly cleaned in fuel oil and inspected. Replace any parts that are damaged or questionable before reassembling the holder.

Make sure that the lapped pressure faces, "B" on the nozzle and "D" on the nozzle holder as shown in Fig. 37, are clean and free from dirt or metallic particles.

13. Carefully clean all carbon deposits from both the inside and outside surfaces of the nozzle cap nut. THE SEATING SURFACE INSIDE THE CAP NUT MUST BE CLEAN.

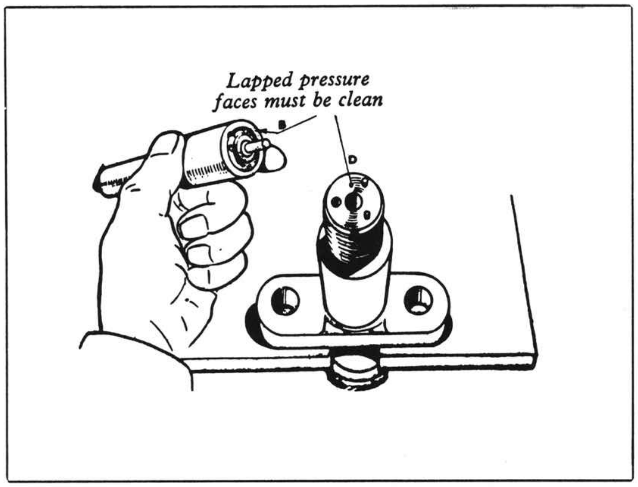
Lapped pressure faces must be clean

Fig. 37. Pressure Faces on Nozzle Body and Nozzle Holder

14. Make sure that the adjusting screw is turned out to release the spring pressure, then align the dowel pins with their respective holes and place the nozzle assembly on the pressure face of its holder. Install the nozzle cap nut as shown in Fig. 38, and TIGHTEN THE CAP NUT TO 50 FT.-LBS. DO NOT OVERTIGHTEN, as this may cause distortion and lead to seizure of the nozzle valve.

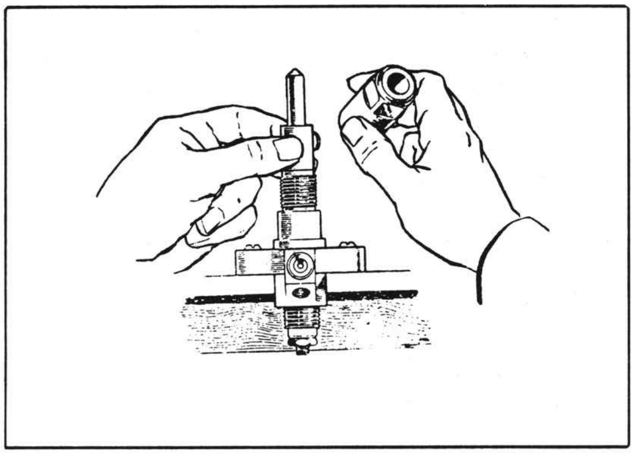

Fig. 38. Installing Nozzle Cap Nut

15. Connect the assembled injector onto a test stand, then adjust and test it for proper operation.

AIR CLEANER

The air cleaner assembly is of the oil bath type and is located in front of the radiator, above the steering pedestal.

Emphasize to your customers the importance of the following items:

1. That the oil cup be cleaned and refilled daily, more often under severe dust conditions.

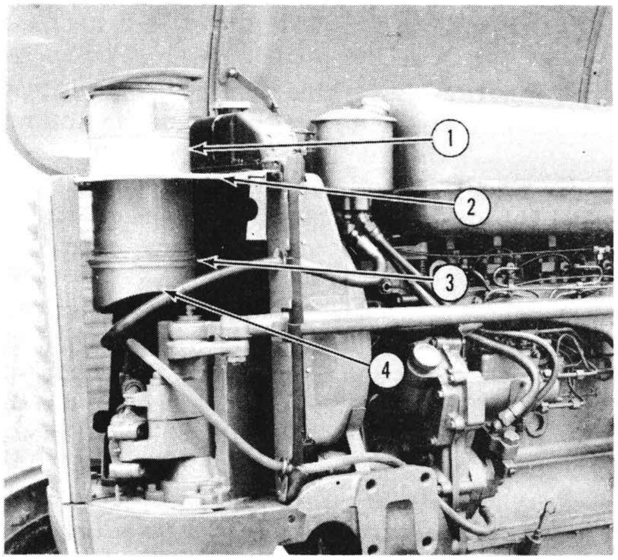

Fig. 39. Air Cleaner Nomenclature

1. Air cleaner body
2. Upper grille plate
3. Oil cup retaining clamp
4. Oil cup

2. That the air cleaner screen be inspected daily and cleaned as necessary. DO NOT OIL THE SCREEN.

3. That the air cleaner be removed and the internal filter be cleaned once or twice a year, or more often as necessary.

PROPER SERVICING OF THE AIR CLEANER IS IMPORTANT AND CANNOT BE OVEREMPHASIZED.

REMOVAL

To remove the air cleaner, open the hood and the front grille assembly and proceed as follows:

1. Disconnect the air cleaner hose from the air cleaner.

2. Remove the oil cup retaining clamp, No. 3, Fig. 39, and the oil cup from the air cleaner.

3. Remove the screws securing the air cleaner body, No. 1, Fig. 39, to the upper grille plate, No. 2, Fig. 39.

4. Lift the air cleaner through the hole in the plate and remove from tractor.

NOTE: To reinstall the air cleaner reverse the steps listed above. Make sure to install the oil cup with the relieved area towards the left hand side of the tractor as shown in Fig. 39.

SERVICING

To thoroughly service the air cleaner, remove it from the tractor and proceed as follows:

1. Empty the oil cup and thoroughly clean it. Fill the oil cup to the oil level mark with the same oil as used in the engine crankcase.

2. Thoroughly clean the internal filter with a steam cleaner (if available), or immerse the air cleaner in a suitable solvent, then rinse and drain thoroughly. Use compressed air and dry out the filter before installing the air cleaner.

CAUTION: Make sure the air cleaner is thoroughly dry before installing it onto the tractor and starting the engine. If the internal filter is saturated with a flammable type of solvent and the engine is started, the solvent may be drawn into the cylinders and cause the engine to overspeed.

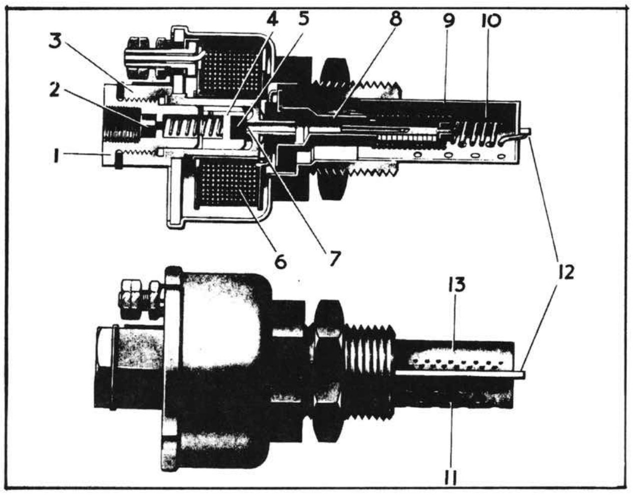

Fig. 40. Cutaway View of Solenoid Type Thermostart

1. Adapter
2. Filter
3. Core
4. Plunger
5. Rubber insert
6. Solenoid
7. Valve seat
8. Coil carrier
9. Heater coil
10. Heater coil
11. Shield
12. Flange
13. Shield

THERMOSTART

The thermostart (cold starting aid) is located in the air inlet end of the intake manifold and when activated, causes fuel to burn inside the intake manifold, thus preheating the incoming air before it is drawn into the cylinders.

Several thermostarts with different part numbers have been installed and are shown in Figs. 40 and 41. The thermostarts are not directly interchangeable due to the size of the tapped holes in the intake manifold and variation in the fuel delivery connections.

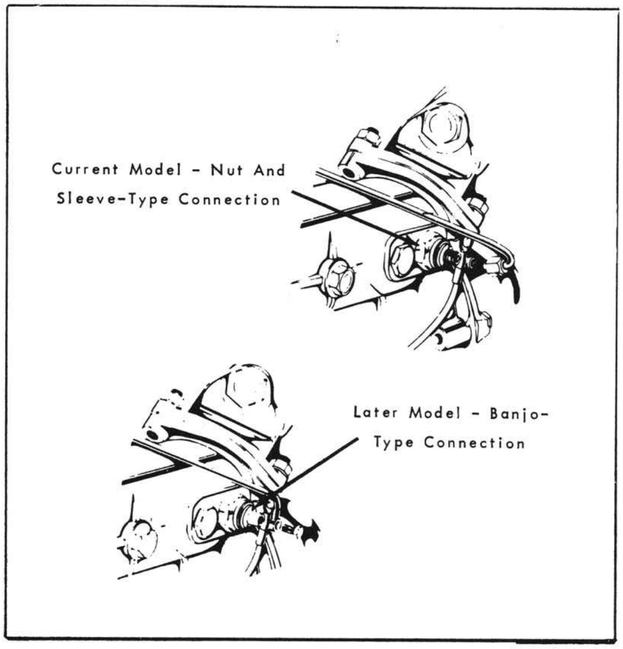
Current Model - Nut And Sleeve-Type Connection
Later Model - Banjo-Type Connection

Fig. 41. Later and Current Model Thermostarts (Mark III Type)

EARLY SHUT-OFF SOLENOID TYPE THERMOSTART

The early thermostart (prior to engine serial number 2804837) is shown in Fig. 40.

Basically, this type of thermostart (as shown in Fig. 40) consists of a core (3), a solenoid (6), a spring-loaded plunger (4) fitted with a special rubber insert (5) which butts against a valve seat (7); a coil carrier (8) bearing two heater coils (9, 10) and a circular shield having large perforations (11) on one side, small perforations (13) on the other and a small flange (12) running along its outer surface.

Fuel oil from the reservoir fills the pipe, adaptor (1), filter (2), hollow plunger (4) and the groove in the surface of the plunger. When the thermostartswitch is operated, the solenoid (6) and coils (9, 10) are energised. Magnetism induced in the plunger (4) and adaptor (1) by the solenoid, draws the plunger and rubber insert off the valve seat(7). Fuel then flows at a controlled rate along and around the coil (9) which vaporizes it. Coil (10) reaches the ignition temperature of the fuel vapor.

As soon as the engine is cranked, fresh air drawn into the inlet manifold enters the circular shield through the small perforations (13) and mixes with the vaporized fuel inside it. The resulting mixture is ignited by coil (10) and so heats the air for combustion as it is drawn into the cylinders, promoting easier ignition of the injected fuel.

The flange (12), running along the outer surface of the shield, provides a sheltered zone around the outlet holes (11), and protects the flame from the incoming air stream.

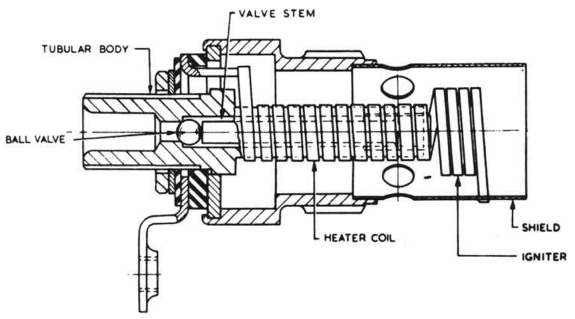

Fig. 42. Cutaway View of C.A.V. Mark III Type Thermostart

LATER AND CURRENT TYPE THERMOSTARTS

The thermostarts as shown in Fig. 41, are of the C.A.V. Mark III type and are composed of a tubular valve body surrounded by a heater coil with an igniter coil extension, See Fig. 42. The body is contained in a holder with an open perforated shield, which screws into the intake manifold.

The valve body houses a needle, the stem of which holds a ball valve in position against its seating. When the unit is cold, the ball valve is held closed and prevents the fuel from entering into the intake manifold. When the electrical switch for the thermostart is turned to the "on" position, the valve body is heated and expands, thus opening the ball valve and permitting the entrance of fuel. The fuel is vaporized by the heat of the valve body and when the engine is cranked and air is drawn into the manifold, the vapor is ignited by the coil extension, thereby heating the incoming air.

When theelectrical switch for the thermostart is turned to the "off" position, the flow of air in the manifold rapidly cools the valve body and the valve closes.

SERVICING THE THERMOSTARTS

Both types of thermostarts are self contained sealed units and cannot be disassembled and serviced. If the thermostart is not operating properly, disconnect the fuel line and electrical wire, and replace the faulty unit. WHEN REPLACING THE SOLENOID TYPE MAKE SURE IT IS INSTALLED WITH THE ARROW ON THE CASTING POINTING IN THE DIRECTION OF AIR FLOW. ALSO, AIR BLEED AND PRIME THE FUEL LINE BEFORE OPERATING THE THERMOSTART.

> *IMPORTANT: Caution your customers to make sure that there is an adaquate supply of fuel for the thermostarts before they are operated. If either type of thermostart is operated without fuel it may cause the coils to be burnt out.*

Specifications For The Thermostarts are as follows:

EARLY SOLENOID TYPE

Voltage	12
Nominal Current Consumption	15 amperes
Fuel Flow Rate Through Thermostart	10 c.c. per min.

C.A.V. MARK III TYPE

Voltage	12
Maximum Current Consumption	18 amperes
Fuel Flow Rate Through Thermostart	9 c.c. per min.

PART 4. LUBRICATION SYSTEM SERVICING

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OIL PAN STRAINER	7
OIL FILTER	7
OIL PRESSURE GAUGE	8

LUBRICATION SYSTEM

The 4-A-203 engine uses a forced-feed type lubrication system, the oil being circulated under pressure by an eccentric lobe rotor-type pump bolted to the front main bearing cap and driven through an idler gear by the crankshaft gear.

In operation, oil is drawn into the oil pump through an oil strainer and a suction pipe. The oil pump, being equipped with a plunger-type relief valve that controls the maximum oil pressure, then pumps the oil through a pipe and into a drilling in the cylinder block to the oil filter on the right hand side of the engine. From the filter the oil then passes through a crosswise drilling to the main oil gallery drilled lengthwise through the left hand side of the crankcase. Crosswise passages through the main bearing housing webs carry the oil from the oil gallery to the main bearings. The oil then passes through drilled holes in the crankshaft to the connecting rod bearings. The cylinder walls and piston pins are splash lubricated by oil from the connecting rod bearings.

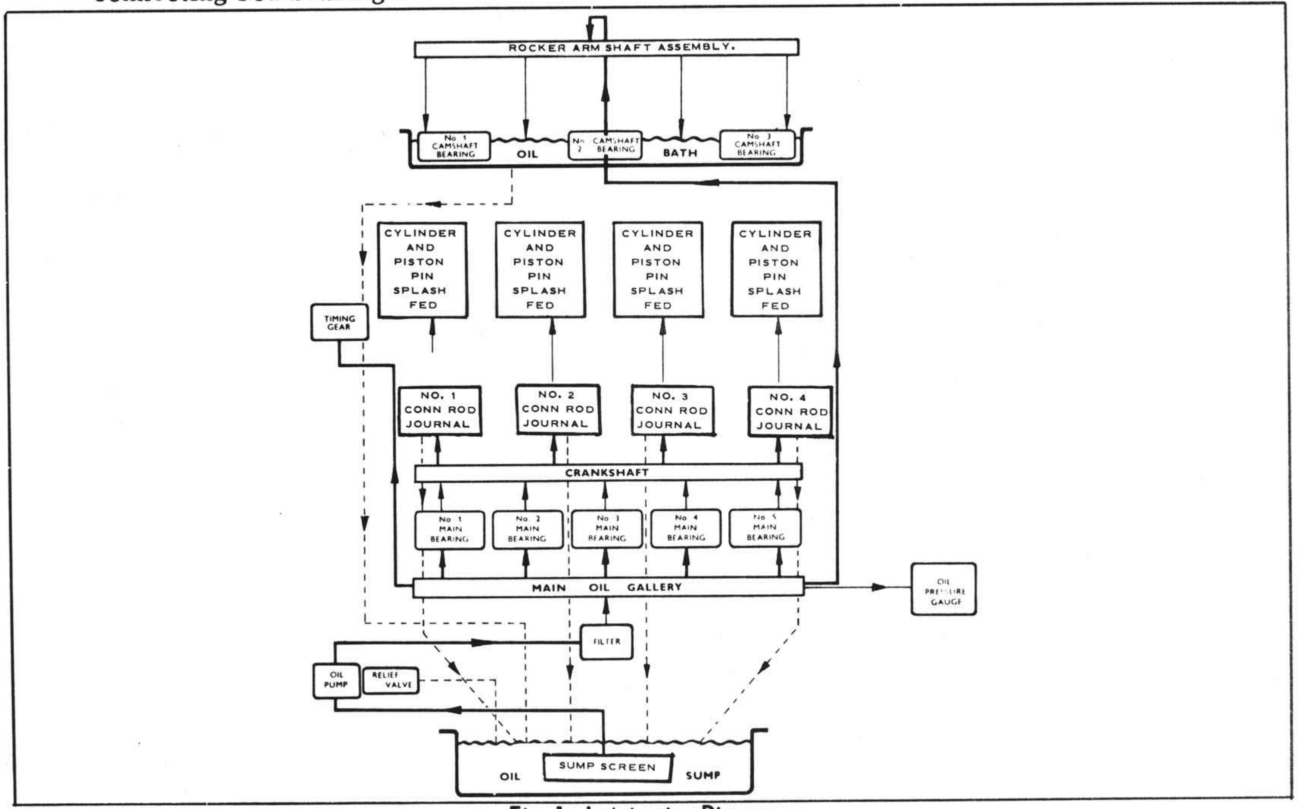
ROCKER ARM SHAFT ASSEMBLY
No 1 CAMSHAFT BEARING
OIL
No 2 CAMSHAFT BEARING
BATH
No 3 CAMSHAFT BEARING
CYLINDER AND PISTON PIN SPLASH FED
CYLINDER AND PISTON PIN SPLASH FED
CYLINDER AND PISTON PIN SPLASH FED
CYLINDER AND PISTON PIN SPLASH FED
TIMING GEAR
NO. 1 CONN ROD JOURNAL
NO. 2 CONN ROD JOURNAL
NO. 3 CONN ROD JOURNAL
NO. 4 CONN ROD JOURNAL
CRANKSHAFT
No 1 MAIN BEARING
No 2 MAIN BEARING
No 3 MAIN BEARING
No 4 MAIN BEARING
No 5 MAIN BEARING
MAIN OIL GALLERY
OIL PRESSURE GAUGE
FILTER
OIL PUMP
RELIEF VALVE
OIL
SUMP SCREEN
SUMP

Fig. 1 - Lubrication Diagram

A drilling across the front of the cylinder block feeds oil under pressure from the main oil gallery to an external oil line located on the right-hand side of the engine. This oil line feeds oil to the center camshaft bearing. A machined slot on the center camshaft journal allows oil to be forced through a drilling in the cylinder head to the rocker arm shaft assembly, once every revolution of the camshaft.

> *NOTE: The amount of oil circulating to the rocker arm shaft assembly is adjustable by means of a slot in the rear end of the rocker shaft. When the slot is positioned vertically, the oil feed holes in the rocker shaft are positioned horizontally and supply a minimum amount of oil to the rocker arms. If the slot is positioned horizontally, then the holes are located immediately below the rocker feed holes and allow maximum oil circulation. In production the slot is set at 30 degrees from the vertical and a punch mark on the rear pedestal indicates this position.*

Oil escaping through a hole in the center of each rocker arm lubricates the valves, guides, and tappets. The camshaft is lubricated by oil draining down from the rocker assembly into a chamber cast into the cylinder block. The oil level in the chamber is controlled by a dam on both sides of the center camshaft bearing. The rear dam in the camshaft tunnel allows oil to spill over into the oil pan and the front dam allows oil to pass to the timing gears by way of a casting in the cylinder block. Besides, being splash lubricated, the timing gears have oil pressure fed to them through drillings in the idler hubs.

> *NOTE: An oil spray pipe is attached to the front of the lower idler hub. This pipe takes oil from the hub and sprays the point of mesh between the lower idler gear and the power steering gear on tractors equipped with power steering.*

The capacity of the crankcase is 7 U.S. quarts when the filter is not changed and 7.5 U.S. quarts when the oil filter is changed.

Oil Pan

The oil pan is made of heavy duty cast iron and is bolted at the front end to the timing gear housing, No. 1, Fig. 2, and to a wedge-shaped adapter, No. 5, Fig. 2, at the rear. The wedge-shaped adapter in turn is bolted to the transmission housing adapter plate, No. 6, Fig. 2. The wedge adapter is designed to allow the removal of the oil pan, without the necessity of removing the front axle, and when installed is so positioned to provide a rigid structure.

> *NOTE: The oil pan and wedge-shaped adapter are finished machined as a pair and should be replaced only as an assembly.*

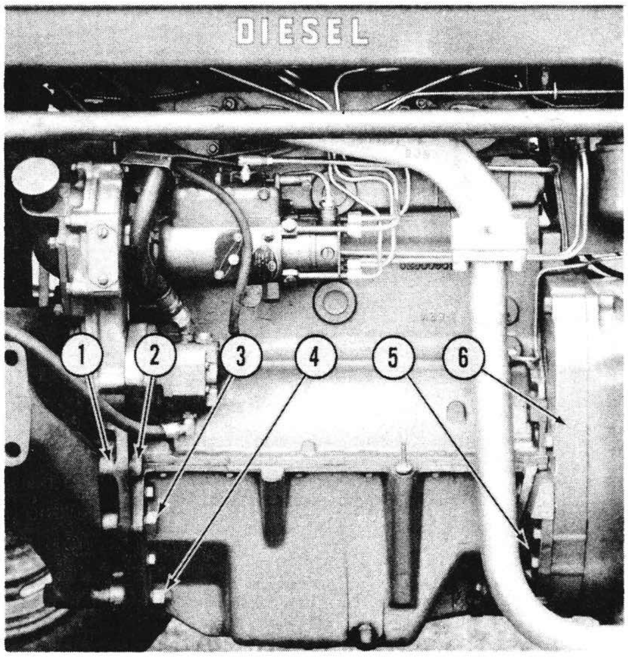

Fig. 2 - Nomenclature

1. Timing Gear Housing
2. Upper Front Axle Support Bolt
3. Center Front Axle Support Bolt
4. Lower Front Axle Support Bolt
5. Wedge-shaped Adapter
6. Transmission Housing Adapter Plate

REMOVAL

1. Drain the crankcase.

2. Remove the center and lower front axle support bolts, Nos. 3 and 4, Fig. 2, that pass through the front of the oil pan. DO NOT REMOVE THE UPPER SUPPORT BOLTS, see No. 2, Fig. 2.

3. Remove the setscrews securing the wedge adapter to the transmission housing adapter plate and the setscrews securing the oil pan to the wedge adapter. Lower the wedge adapter and remove it with the rubber gaskets, No. 5, Fig. 3, which are positioned on both sides between the top of the wedge and the cylinder block.

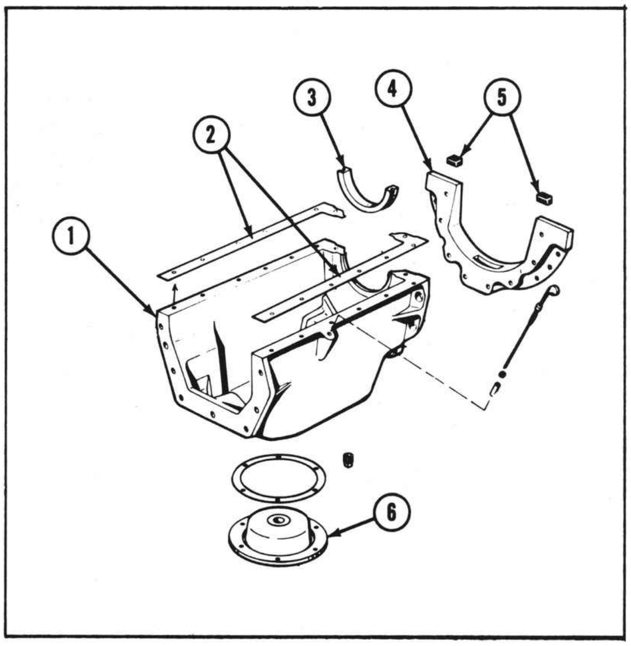

Fig. 3 - Oil Pan and Sequence of Parts

1. Oil Pan
2. Top Oil Pan Gaskets
3. End Oil Pan Gasket
4. Wedge-shaped Adapter
5. Rubber Gaskets (Adapter-to Block)
6. Oil Strainer Assembly

4. Remove the two setscrews and copper washers located at the rear corners underneath the adapter, securing the rear of the oil pan to the cylinder block.

5. Remove the setscrews securing the oil pan to the timing gear housing.

6. Place a floor jack under the oil pan to prevent the oil pan from dropping after all the bolts are removed and joints broken.

7. Remove the remaining setscrews securing the oil pan to the cylinder block and remove the oil pan being careful not to damage the gasket between the oil pan and the timing gear housing.

> *NOTE: In instances where the oil pan is difficult to remove, LOOSEN (do not remove) the upper support bolts, No. 2 Fig. 2, to facilitate removal of the oil pan.*

8. Remove the oil strainer assembly from the bottom of the oil pan and thoroughly clean it and the oil pan.

Oil Pan Installation

1. Make sure that the gasket between the oil pan and timing gear housing is not damaged, then use new gaskets, No. 2, Fig. 3, between the oil pan and the cylinder block and a new gasket, No. 3, Fig. 3, between the rear of the oil pan and the rear main bearing cap. Position the oil pan to the cylinder block and timing gear housing, and locate it in position, BUT DO NOT TIGHTEN THE SETSCREWS.

> *NOTE: Use a non-hardening type of sealing compound between the oil pan and the timing gear housing gasket.*

2. Pull the oil pan to the timing gear housing by tightening the setscrews securing the oil pan to the timing gear housing.

3. Tighten the setscrews securing the oil pan to the cylinder block. Use new copper washers with the two setscrews at the rear of the oil pan.

4. Position the wedge adapter between the oil pan and the transmission housing adapter plate and locate the two rubber gaskets between the top of the wedge adapter and the cylinder block.

5. Install the setscrews securing the wedge to the transmission housing adapter plate and the setscrews securing the oil pan to the wedge, BUT DO NOT TIGHTEN.

6. Use a jack and press the wedge up as far as it will go and tighten the setscrews.

> *NOTE: When assembling the engine on an engine stand, make sure that the wedge adapter is fully seated and tightened securely; however, DO NOT excessively tighten the adapter as it could distort the transmission housing adapter plate when it is not supported by the tractor transmission.*

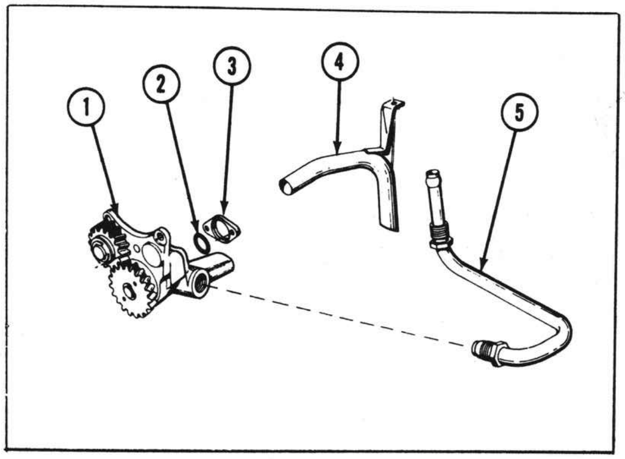

Fig. 4 - Oil Pump

1. Oil Pump Assembly
2. "O"-Ring (Flange)
3. Flange (Suction Pipe - to - Relief Housing)
4. Oil Suction Pipe Assembly
5. Oil Delivery Pipe

7. Install the oil strainer assembly.

Oil Pump

The oil pump, No. 1, Fig. 4, has a capacity of 5.75 U.S. gallons per minute at an engine speed of 2,000 RPM and is mounted on the front main bearing cap and is secured by three capscrews. The rear end of the idler gear shaft, No. 5, Fig. 5, extends through the oil pump body, No. 7, Fig. 5, and locates in a hole in the bearing cap to provide positive location of the oil pump.

In operation the idler gear, No. 3, Fig. 5, rotates on the idler gear shaft which is pressed into and pinned to the pump body and transmits the drive from the crankshaft gear to the oil pump drive gear, No. 20, Fig. 5.

The oil pump drive gear is pressed and keyed on the front of the inner four-lobed eccentric rotor, see No. 9, Fig. 5. This inner rotor meshes with an outer five-lobed rotor, No. 10, Fig. 5, which is free to rotate in the pump body.

As the oil-pump gear revolves, oil from the vacant space over the inlet port is transferred to the outlet port from which it is forced out of the pump as the lobes engage.

The oil pressure relief valve is incorporated in the pressure side of the relief valve housing, No. 14, Fig. 5, and controls the maximum oil pressure at 50 - 65 psi.

Removal

The oil pump may be removed either with the timing gear cover and oil pan removed, or with just the oil pan removed.

To remove the oil pump with the timing gear cover and oil pan removed, proceed as follows:

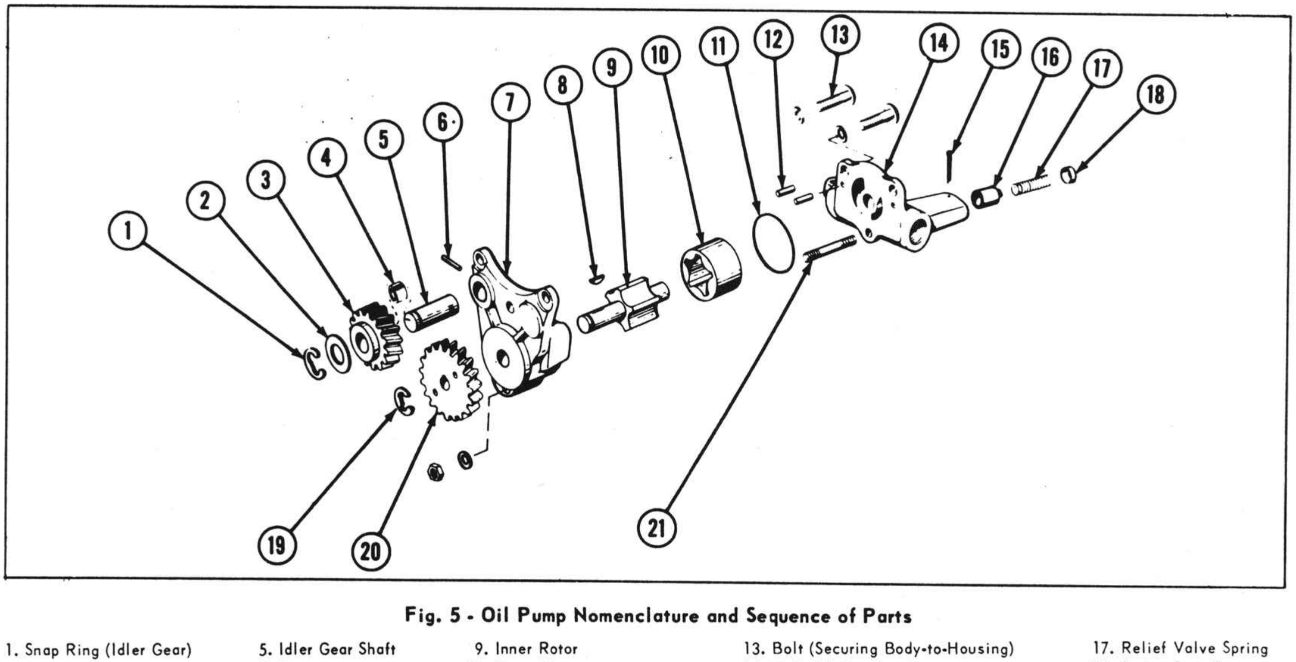

Fig. 5 - Oil Pump Nomenclature and Sequence of Parts

1. Snap Ring (Idler Gear)
2. Washer
3. Oil Pump Idler Gear
4. Idler Gear Bushing
5. Idler Gear Shaft
6. Pin
7. Oil Pump Body
8. Drive Gear Key
9. Inner Rotor
10. Outer Rotor
11. "O"-Ring (Housing-toBody)
12. Locating Pins
13. Bolt (Securing Body-to-Housing)
14. Relief Valve Housing
15. Cotter Pin
16. Relief Valve Plunger
17. Relief Valve Spring
18. Spring Seat Cup
19. Snap Ring (Drive Gear)
20. Oil Pump Drive Gear
21. Stud

> *NOTE: Check the backlash in the oil pump gears with a dial indicator or feeler gauge. Normal backlash is 0.012 - 0.018 inch. If backlash exceeds specifications, install new gears when reassembling the oil pump.*

1. Disconnect and remove the suction pipe, see No. 4, Fig. 4.

2. Disconnect and remove the oil delivery pipe, see No. 5, Fig. 4.

3. Remove the idler gear retaining snap ring, No. 1, Fig. 5, and remove the idler gear washer, No. 2, Fig. 5, and idler gear.

4. Remove the setscrews securing the oil pump to the front main bearing cap and remove the oil pump.

> *NOTE: To remove the oil pump with only the oil pan removed, perform steps No. 1 and No. 2, then remove the bolts securing the front main bearing cap and oil pump as an assembly.*

Disassembly

To disassemble the oil pump, refer to Fig. 5, and proceed as follows:

1. Remove the oil pump drive gear from the oil pump as shown in Fig. 6.

2. Remove the drive gear key, No. 8, Fig. 5.

3. Unbolt and separate the oil pump body, No. 7, Fig. 5, from the relief valve housing, No. 14, Fig. 5.

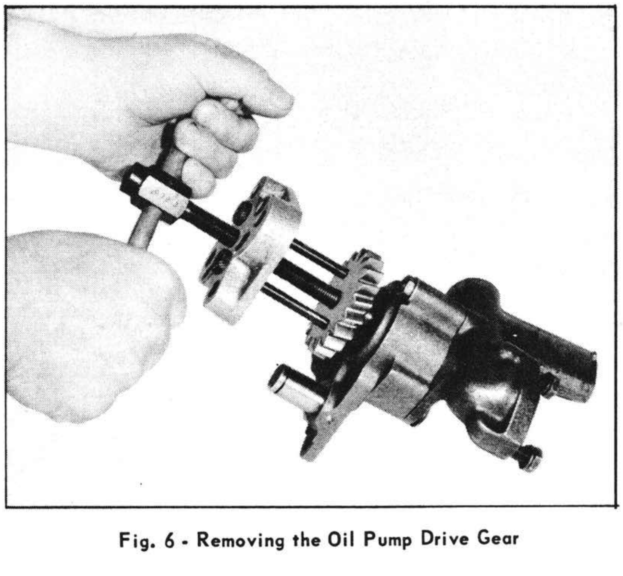

Fig. 6 - Removing the Oil Pump Drive Gear

4. Remove the "O" ring, as shown in Fig. 7.

5. Carefully remove the inner and outer rotors from the pump body.

6. Disassemble the relief valve by removing the cotter pin, No. 15, Fig. 5, (and shims where provided), the spring seat cap, No. 18, Fig. 5, spring, No. 17, Fig. 5, and relief valve plunger, No. 16, Fig. 5.

Inspection

To inspect the oil pump, thoroughly clean all parts and proceed as follows:

1. Inspect the rotors for cracks or scores.

2. Install the rotors in the pump body.

> *NOTE: The chamfered edge of the outer rotor must be installed towards the front of the oil pump.*

Measure the clearance between the maximum diameter of the inner rotor and the minimum diameter of the outer rotor at all points, as shown in Fig. 8. If clearance exceeds 0.006 inch, replace the inner and outer rotors as a matched pair.

3. Measure the clearance between the outer

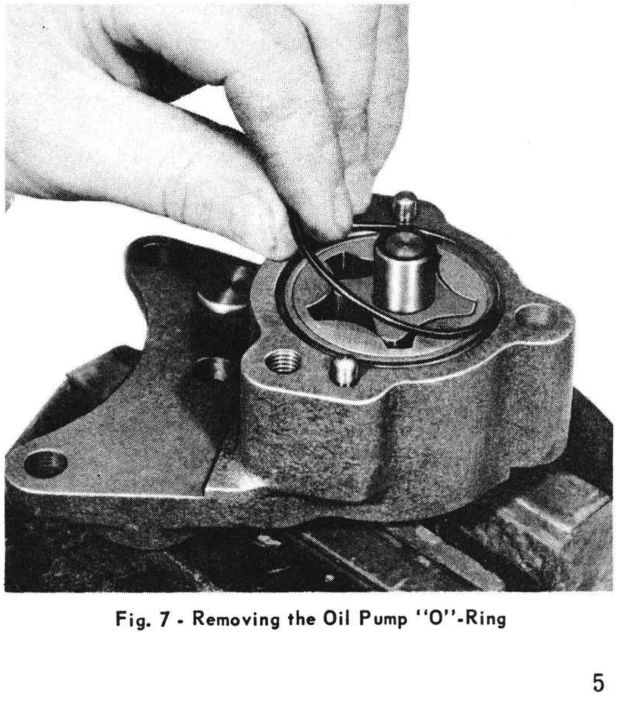

Fig. 7 - Removing the Oil Pump "O"-Ring

rotor and the pump body, as shown in Fig. 9. If clearance exceeds 0.010 inch, replace the pump body and rotor assembly.

4. Measure the clearance between the top of the rotors and the face of the pump body with a feeler gauge and straight edge, as shown in Fig. 10. If clearance exceeds 0.003 inch, replace pump body and rotor assembly.

5. Inspect the oil pump relief valve spring and replace it if it does not meet the following specifications:

Free Length . . . . 1-1/2 inches
Lbs. Pressure @ 1-1/4 inches. . . . .
5-1/4 - 7-1/4 lbs.
Lbs. Pressure @ 1 inch. . . . .
11-1/2 - 13-1/2 lbs.

Reassembly

To reassemble the oil pump, reverse the steps listed under "Disassembly".

> *NOTE: Make sure to install the chamfered edge of the outer rotor toward the front of the oil pump. The flat face of the oil pump drive gear must be toward the front of the engine and the gear pressed on the shaft until it is flush with the snap ring groove.*

Oil Filters

Three oil filters are incorporated into the lubrication system of the 4A-203 engine and are listed as follows:

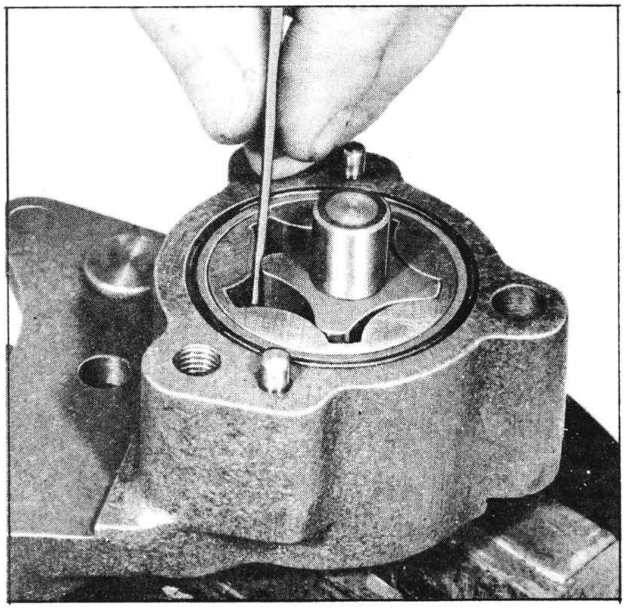

Fig. 8 - Checking Clearance Between Inner and Outer Rotors

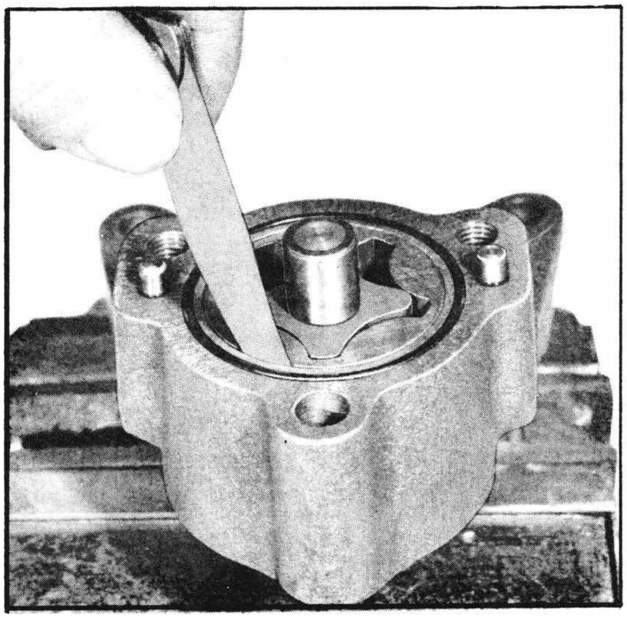

Fig. 9 - Checking Clearance Between Outer Rotor and Pump Body

1. Oil filler strainer
2. Oil pan strainer assembly
3. Main oil filter.

OIL FILLER STRAINER

The oil filler strainer is a part of the oil filler cover bolted onto the front of the timing gear cover. The purpose of the strainer is to prevent large foreign particles from entering the engine.

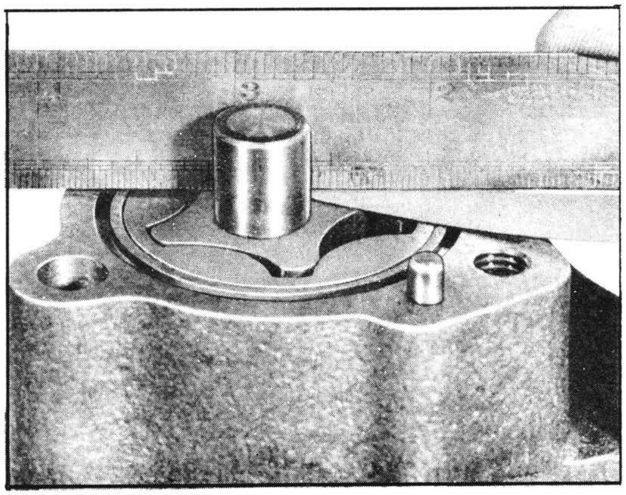

Fig. 10 - Checking Clearance Between Rotor Faces and Pump Body

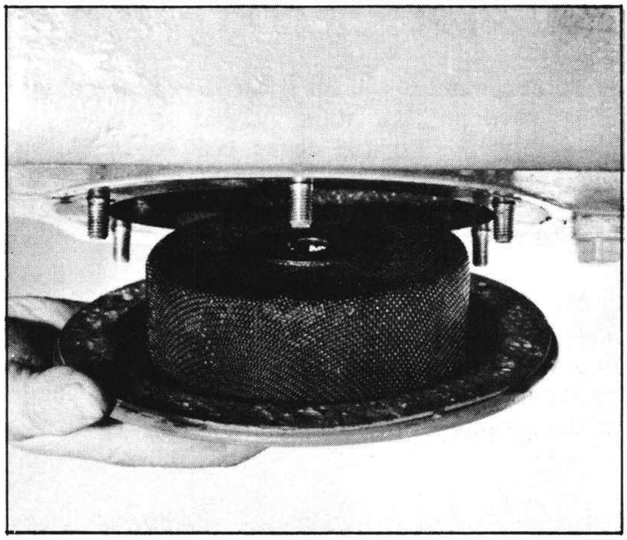

Fig. 11 - Oil Pan Strainer Assembly

OIL PAN STRAINER ASSEMBLY

The oil pan strainer assembly is located in the bottom of the oil pan, as shown in Fig. 11. The function of the strainer is to fit over the oil pump suction pipe and filter the oil before it is drawn into the oil pump.

OIL FILTER

The main full-flow filter, as shown in Fig. 12, is mounted on the right-hand side of the engine crankcase and contains a by-pass valve.

In operation, oil is forced by the oil pump through the inlet port of the filter head to the outside surfaces of the filter element. The oil is filtered as it passes toward the center of the filter element and is forced out through the outlet port. In the event that the filter element becomes clogged and the passage of oil restricted, differential pressure built up in the inlet port will open the spring-loaded ball valve in the by-pass and will allow unfiltered oil to pass into the outlet port. The spring loaded ball valve opens at 13 to 17 psi differential pressure.

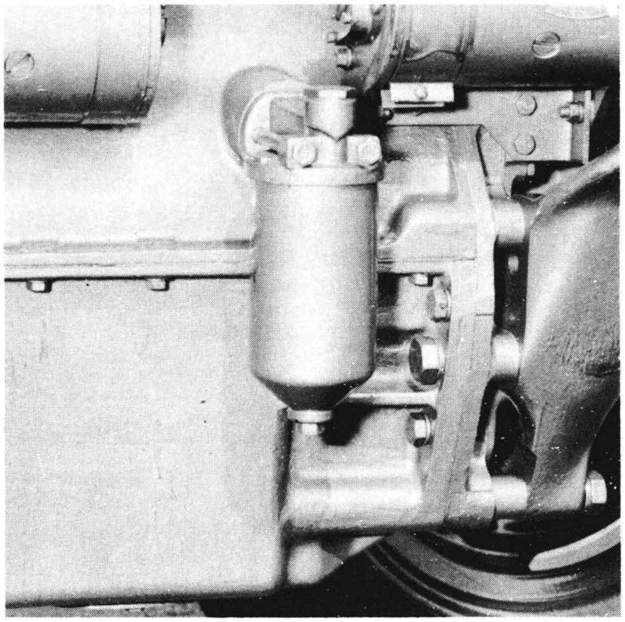

Fig. 12 - Oil Filter on Right Hand Side of Engine

Disassembly

To disassemble the oil filter, refer to Fig. 13, and proceed as follows:

1. Unscrew the cover bolts, No. 14, Fig. 13, and remove the filter body and element.

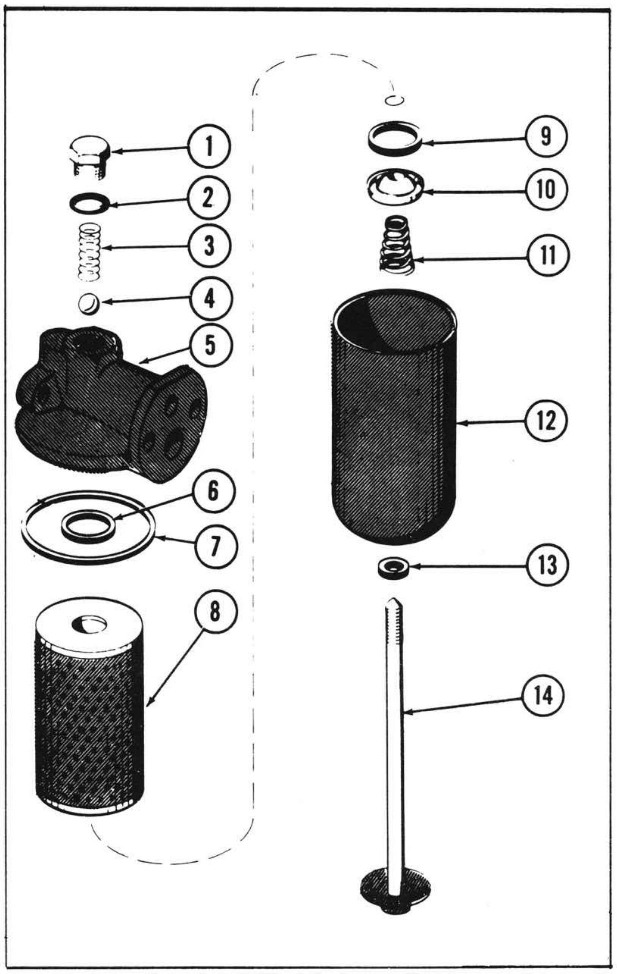

Fig. 13 - Oil Filter Nomenclature and Sequence of Parts

1. Relief Valve Plug
2. Plug Gasket
3. Relief Valve Spring
4. Relief Valve Ball
5. Filter Cover Assembly
6. Upper Element Gasket
7. Cover To Body Gasket
8. Oil Filter Element
9. Lower Element Gasket
10. Lower Gasket
11. Element Pressure Spring
12. Oil Filter Body Assembly
13. Cover Bolt Washer
14. Cover Retaining Bolt

2. Remove the two bolts securing the filter cover assembly, No. 5, Fig. 13, to the cylinder block and remove filter cover from block.

3. Remove large gasket, No. 7, Fig. 13, and smaller gasket, No. 6, Fig. 13, from filter cover.

4. Remove the relief valve plug, No. 1, Fig. 13, gasket, No. 2, Fig. 13, spring No. 3, Fig. 13, and relief valve ball, No. 4, Fig. 13.

5. Discard the old element and clean all parts with solvent.

REASSEMBLY

To reassemble the oil filter, use new gaskets and reverse the steps listed under "Disassembly". Tighten cover bolt to 10 ft.-lbs. torque.

OIL PRESSURE GAUGE

Normal operating pressure is 25 to 60 psi. The oil pressure may be checked by disconnecting the oil pressure gauge line at the cylinder block and connecting a master gauge at the fitting.

GROUP 1 — SECTION C — PART 5

PART 5. COOLING SYSTEM SERVICING

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Radiator 1
Water Pump 2
Thermostat 5
Fan Belt 6

The cooling system for the 4A-203 engine is the pressure circulated type, i.e., pressurized radiator, belt driven pump, thermostat, and cylinder block jacket containing dry sleeves. The cooling system capacity is 10 U.S. or 8 Imp. quarts. The radiator cap is the pressurized type, set to release radiator pressure at 10 pounds per square inch. The thermostat begins to open at 172°F and is fully opened at 176°F.

The coolant liquid is circulated through the system from the water pump, around the cylinder walls, up through the cylinder head, then either through a by-pass tube from the thermostat housing direct to the water pump, or through the thermostat to the top of the radiator, down through the radiator core and back to the pump, depending on coolant temperature.

When the coolant temperature is below 172°F, the thermostat remains completely closed, thus preventing any circulation through the radiator. As the coolant temperature rises above 172°F, the thermostat opens slightly which permits a limited flow of coolant through the radiator. As the coolant temperature continues to rise, the thermostat opens in proportion. Thus the thermostat can regulate the engine temperatures by regulating the volume of flow of coolant through the radiator up to that point of maximum opening of the thermostat which is attained at 176°F.

In those areas where there is a high content of calcium (Lime) or iron in the water that will be used for filling the cooling system, it is recommended that either a preventive inhibitor be added to the water or rain water be used. There are a number of reputable commercial inhibitors on the market that are satisfactory. It might be advisable to consult a local chemist to determine what particular type of inhibitor is most suitable for local conditions. When an anti-freeze solution is used in the cooling system, it will not be necessary to add an inhibitor since all reputable anti-freeze solutions contain this additive.

RADIATOR

The radiator is a copper tube and fin-type. It is equipped with a spring loaded pressure-type cap calibrated to open the overflow at 10 pounds pressure per square inch. This eliminates spilling of coolant through the overflow pipe. It also reduces evaporation losses because it raises the boiling point of the coolant to approximately 240°F.

REMOVAL

Remove the following:

1. Radiator cap, drain the cooling system and remove the hood.

2. Disconnect the lines from the thermostart reservoir. This is the small fuel container mounted on top of the upper radiator support.

3. Power steering oil reservoir from the top radiator support, lay it on its side and drain the oil into a clean container.

4. Disconnect the upper and lower hose tubes and remove the upper radiator support.

5. Fan blade assembly from the front end of the water pump and lay it in the radiator shroud.

6. Grommet support from the left side of the radiator.

7. Four cap screws securing the radiator on the tractor.

SERVICING

For radiator and general cooling system servicing information, refer to the General Engine Section, Group 1, Section A, Part 5. If the radiator is damaged or the tubes require cleaning, consult a competent radiator shop.

WATER PUMP

REMOVAL

1. Drain the radiator.

2. Loosen the rear clamp securing the rear end of the radiator hose on the upper pump outlet.

3. Loosen the clamp securing the radiator hose on the lower pump outlet.

Remove the following:

1. Fan belt. Note that there is a "high spot" at the upper right part of the radiator shroud through which the belt will pass the fan blade ends.

2. Fan blade assembly from the pump. The blade assembly can be withdrawn from the radiator shroud.

3. Two cap screws securing the by-pass hose elbow to the thermostat housing.

4. Two cap screws securing the right side of the pump to the engine

5. Remove the two cap screws securing the left side of the pump to the engine. The pump will have to be moved forward as the lower cap screw is being screwed out because the head of the cap screw will not clear the belt pulley flange. The pump can now be removed.

> *CAUTION: Care must be exercised to prevent the pump from falling forward and damaging the radiator fins and tubes when the last supporting cap screw is removed.*

DISASSEMBLY

To disassemble the water pump refer to Fig. 1 and remove the following:

1. Self locking nut on the end of the pump shaft.

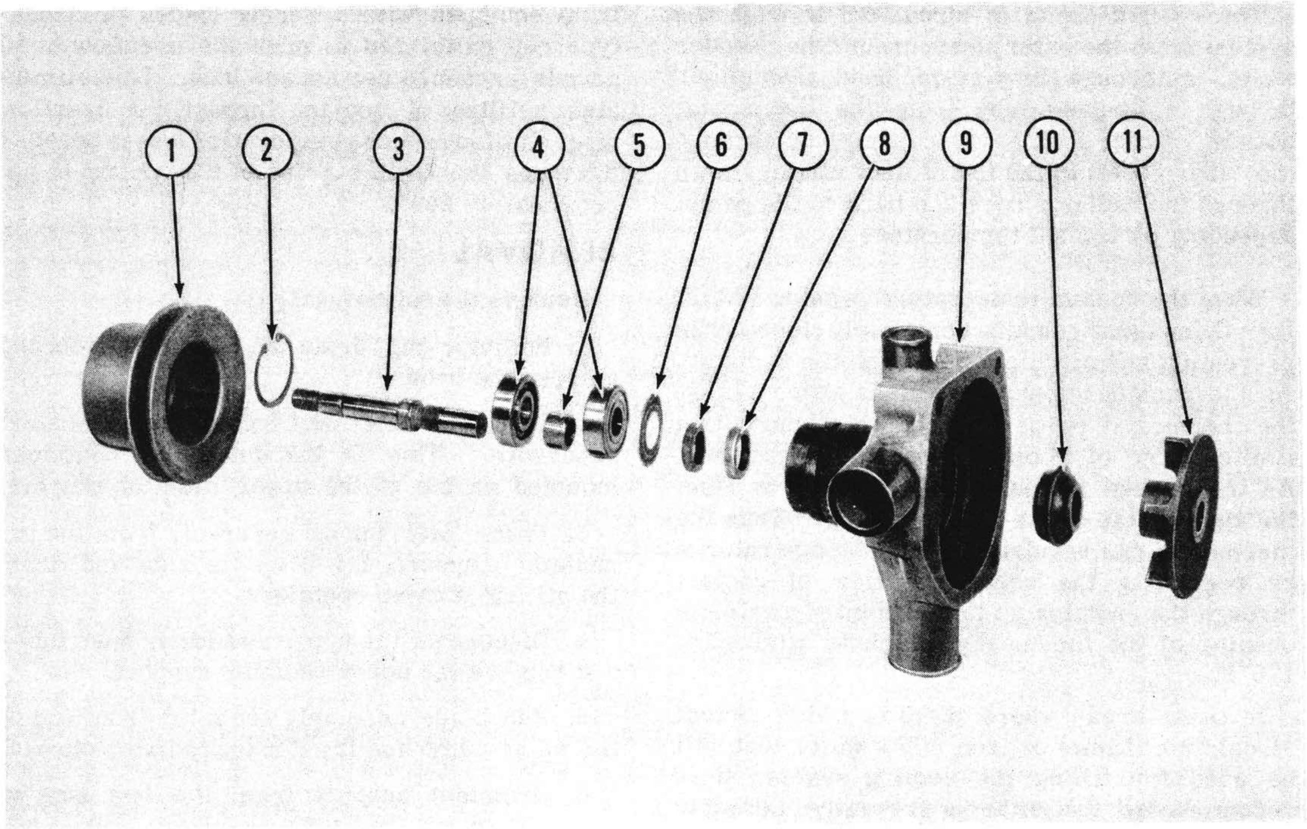

Fig. 1 — Water Pump Nomenclature and Sequence of Parts

1. Pulley
2. Bearing Retaining Snap Ring
3. Shaft
4. Bearing
5. Bearing Spacer
6. Felt Seal Retainer
7. Pump Bearing Seal
8. Felt Seal Housing
9. Water Pump Body
10. Water Pump Seal
11. Impeller

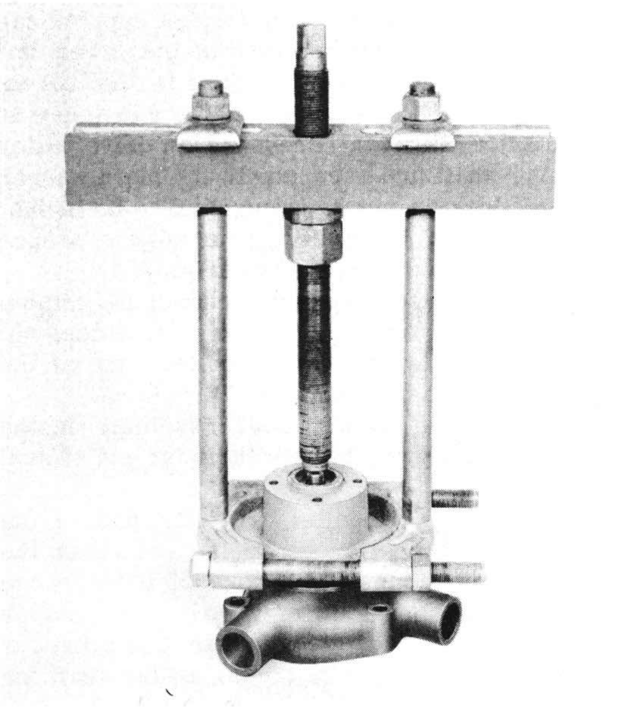

Fig. 2 – Removing Water Pump Pulley

2. Belt pulley with a sheave puller, see Fig. 2.

3. Snap ring, Fig. 3.

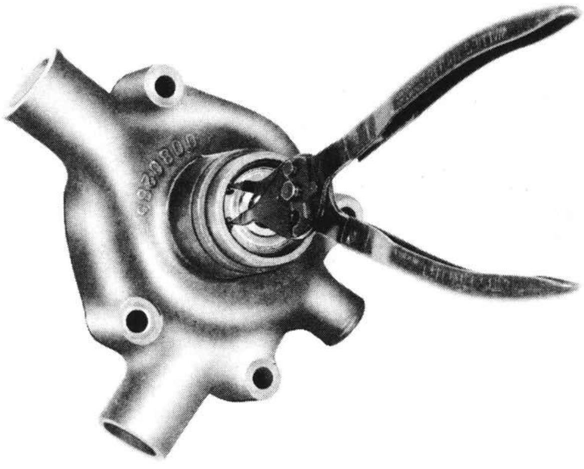

Fig. 3 – Removing Snap Ring

4. Mount the pump in an arbor press and push the shaft out of the impeller, see Fig. 4.

5. The plastic seal assembly, No. 10, Fig. 1.

6. The outer felt retaining washer, the felt seal, and retaining cup, Nos. 6, 7 and 8, Fig. 1. Discard the felt seal retainers and the plastic seal assembly.

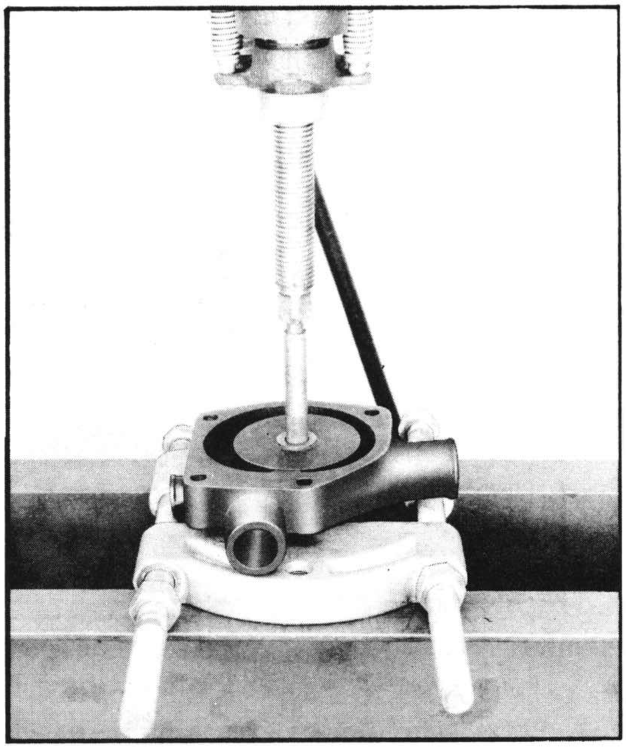

Fig. 4 – Pressing Shaft Out of Impeller

INSPECTION

1. Rotate the bearings on the shaft by hand. If the bearings are smooth and free, the assembly is serviceable and may be reinstalled. If the bearings are rough or the inner races not tight on the shaft, they must be replaced. They can be removed by pushing them and the spacer between them toward the threaded end of the shaft. If the bearings are satisfactory, wash them thoroughly in clean solvent.

2. Carefully examine the machined surface of the impeller hub that contacts the plastic seal. If this surface is rough or pitted to an extent that the plastic seal will not make adequate contact with it to prevent the coolant from leaking between it and the hub, a new impeller must be installed. Also check the impeller for cracks or broken blades.

3. Check the housing for cracks in the body. Also inspect the "Bleeder" hole in pump inlet to be sure it is not plugged. See Fig. 5.

REASSEMBLY

1. Pack the races of the ball bearings with water pump grease and press them in place on the shaft with the spacer No. 5, Fig. 1, in between them. The sealed end of the bearings are to face outward or toward each end of the shaft. See No. 4, Fig. 1.

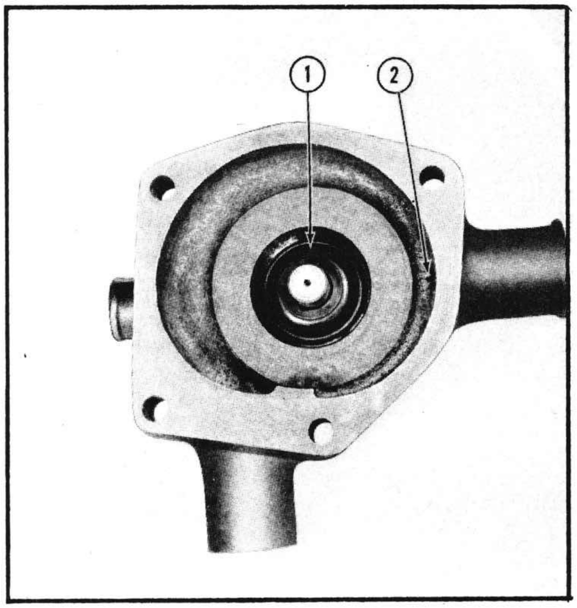

Fig. 5 – Nomenclature

1. Water Pump Seal 2. Bleeder Hole

2. Put a thin film of grease on the inside diameter of a new felt seal and insert it in the retaining cup.

3. Place the felt retaining washer against the felt seal and place the assembly on the shaft as shown on Fig. 6, smearing the assembly with grease to assist in holding the parts in place. Note that the retaining washer is "dished". The dished surface is to rest against the felt washer or away from the inner race of the bearing.

4. Fill the space between the bearings half full of water pump grease and press the bearing and shaft assembly into the pump body. Apply the pressure to the inner race of the bearing, being careful not to damage the bearing's metal seal or the felt retainers. If pressure is applied to the end of the shaft instead of the bearing, the shaft may shift in the bearings. Secure with snap ring, No. 2, Fig. 1.

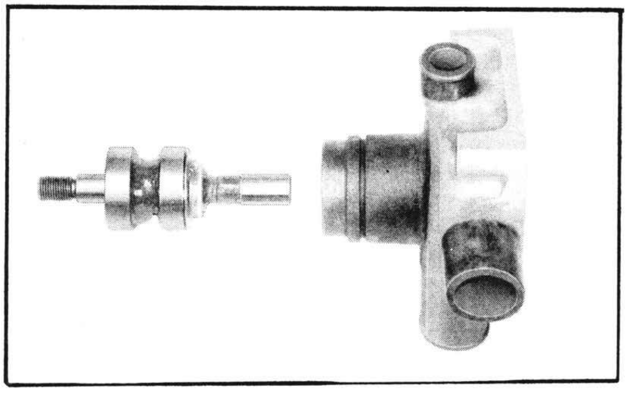

Fig. 6 – Parts Correctly Installed Onto Shaft

5. Insert one of the two longest support cap screws with a lock washer in the lower left hole in the pump body. (This is the fuel injector side of the engine and the cap screw is 3/8 x 3 N.F. thread). Press the fan drive pulley onto the shaft and secure with the plain washer and self-locking nut tightened to 55 - 60 ft. lbs. This torqueing is necessary to ensure proper positioning of shaft in the pump body.

6. At this stage the shaft should be rotated by hand to insure free rotation. If it does not rotate freely strike the impeller end of the shaft with a plastic hammer.

7. Insert the plastic seal assembly in the recess in the pump body with metal end of seal to the inside.

8. Press the impeller onto its end of the shaft. The impeller is to be located on the shaft, to provide .015" to .025" clearance between the inner side of the impeller blades and the pump body. See Fig. 7. The pressure should be against the pulley end of the shaft for this operation. Again rotate the shaft to be sure it turns freely.

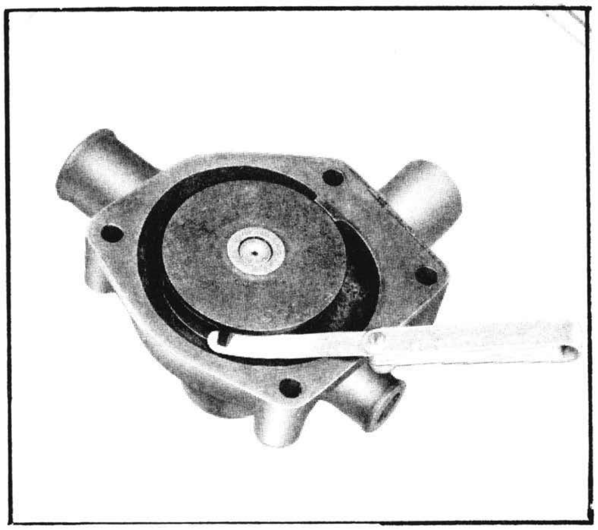

Fig. 7 – Measuring Distance Between Impeller Vanes and Pump Body

9. Clean the rear surface of the pump body and the front end of the engine where the pump fits. Apply a coat of gasket sealer to the surfaces and using a new gasket, mount the pump on the engine, engaging the water hoses at the same time. Note that there are remaining three different lengths of mounting cap screws. Install the shortest cap screw (fully threaded) in the upper right (Fuel injector pump) side using a copper washer on the head. Install the longest cap screw in the upper right (Generator) side

using a lock washer. A copper washer goes on the remaining cap screw which holds the generator adjusting strap. The copper washer goes next to the head of the cap screw.

10. Securely tighten the clamps on the water hoses.

11. Replace the fan blade assembly and the fan belt.

12. Bolt the by-pass elbow to the thermostat body, using a new gasket.

> *NOTE: Water pumps on engine serial No. 2806843 and up require a different water pump shaft and fan pulley than those on engines prior to that serial number. For engine serial No. 2806843 and up, use for repairs Part No. 731806M1 shaft; and Part No. 731805M1 pulley. Corresponding parts for engines prior to 2806843 are Part No. 731167M1 shaft; and Part No. 731173M1 pulley. The difference is that the bore of the pulley hub and shaft end is smaller on the earlier engines. All other parts of the pump are interchangeable with either size of shaft and pulley.*

THERMOSTAT

The thermostat as shown in Fig. 8, is located in the thermostat body which is mounted on the front end of the cylinder head. The thermostat bellows is assembled downwardly in the housing. A narrow recess in the housing locates the rim of the thermostat. There is no directional location needed for the thermostat.

At temperatures below 172°F, (plus or minus 5°) the thermostat remains completely closed, thus limiting the flow of coolant to recirculate through the engine. At temperatures between 168°F and 176°F the thermostat gradually opens thus graduating the flow of coolant through the radiator. When the coolant reaches 176°F, the thermostat is fully opened. In lower ambient temperatures the thermostat will remain partly closed or sufficiently closed to maintain the desired engine temperature.

The temperature at which the thermostat valve should open is stamped on the thermostat frame. If it does not correspond with the figures in the above paragraph, the thermostat is incorrect.

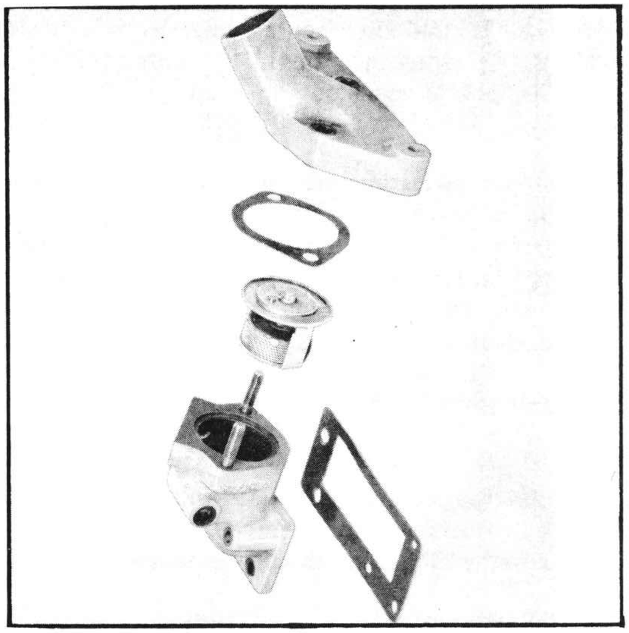

Fig. 8 – Proper Location of Thermostat and Sequence of Parts

REMOVAL

1. Drain the cooling system.

2. Remove the upper radiator hose.

3. Remove fuel line from front end of fuel tank to the small thermostart reservoir.

4. Remove the one bolt holding the thermostart reservoir on its support.

5. Remove the three bolts securing the hydraulic oil tank support to the radiator and the thermostat elbow. Slide the tank to the left, drain the oil in a clean container and let the tank hang over the steering drag link.

6. Disconnect the fuel line from the rear end of the fuel tank.

7. Loosen the two bolts holding down the rear end of the fuel tank.

8. Remove the two nuts and the spring from the two bolts holding down the front end of the fuel tank.

9. Raise the front end of the fuel tank about 3 inches. If the tank is nearly empty, it is best to remove it from the tractor.

10. Remove the cover, (water outlet), from the top of the thermostat body and lift out the thermostat.

INSPECTION

1. Check the thermostat for a broken frame or ruptured bellows.

2. Check the thermostat action as outlined in the General Engine Section, Group 1, Section A,

Part 5. If the thermostat begins to open at 165°F. or does not begin to open at 178°F., the thermostat must be replaced.

The precise tempeature at which the thermostat opens can be checked by gently opening the thermostat valve from its seat and inserting a .002'' feeler gauge between the valve and seat. Hang the thermostat on the feeler gauge as outlined in Page 3, Group 1, Section A, Part 5. Thus, the instant the valve opens, the thermostat will fall to the bottom of the container.

If the thermostat does not function within the above specified temperatures, replace it with a new one which also should be tested.

Do not attempt to repair or adjust either a new or used thermostat.

NOTE: Early model engines were equipped with thermostats stamped 158° opening temperature. When replacing these early thermostats install the current type with the higher opening temperature.

INSTALLATION

1. Clean the old gasket material from the mating surfaces of the thermostat body and the cover.

NOTE: Be careful that none of the old gasket material is allowed to fall into the interior of the body.

2. Install the thermostat into thermostat body with the bellows downwardly and, using a new gasket, reassemble by reversing the removal procedure. Test for leaks after the assembly is completed.

FAN BELT

Check the fan belt for cracks or frayed cover. If either exist, belt life is questionable. If the belt is in acceptable condition, install it and adjust it to correct tension as illustrated in Fig. 9. Do not tighten the belt ''fiddle string'' tight.

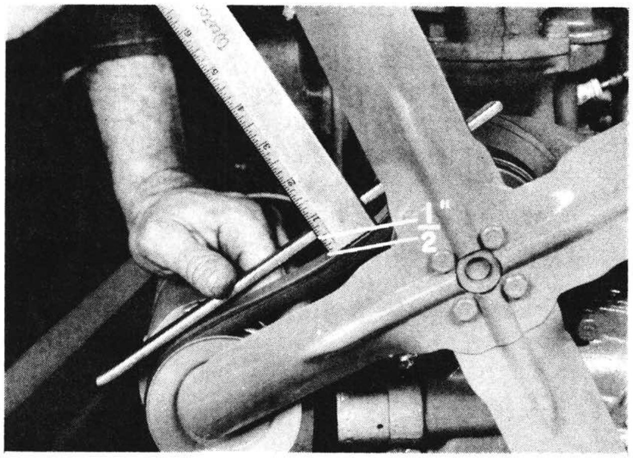

Fig. 9 – Measuring Fan Belt Deflection

GROUP I — SECTION C — PART 6

ELECTRICAL SYSTEM SERVICING

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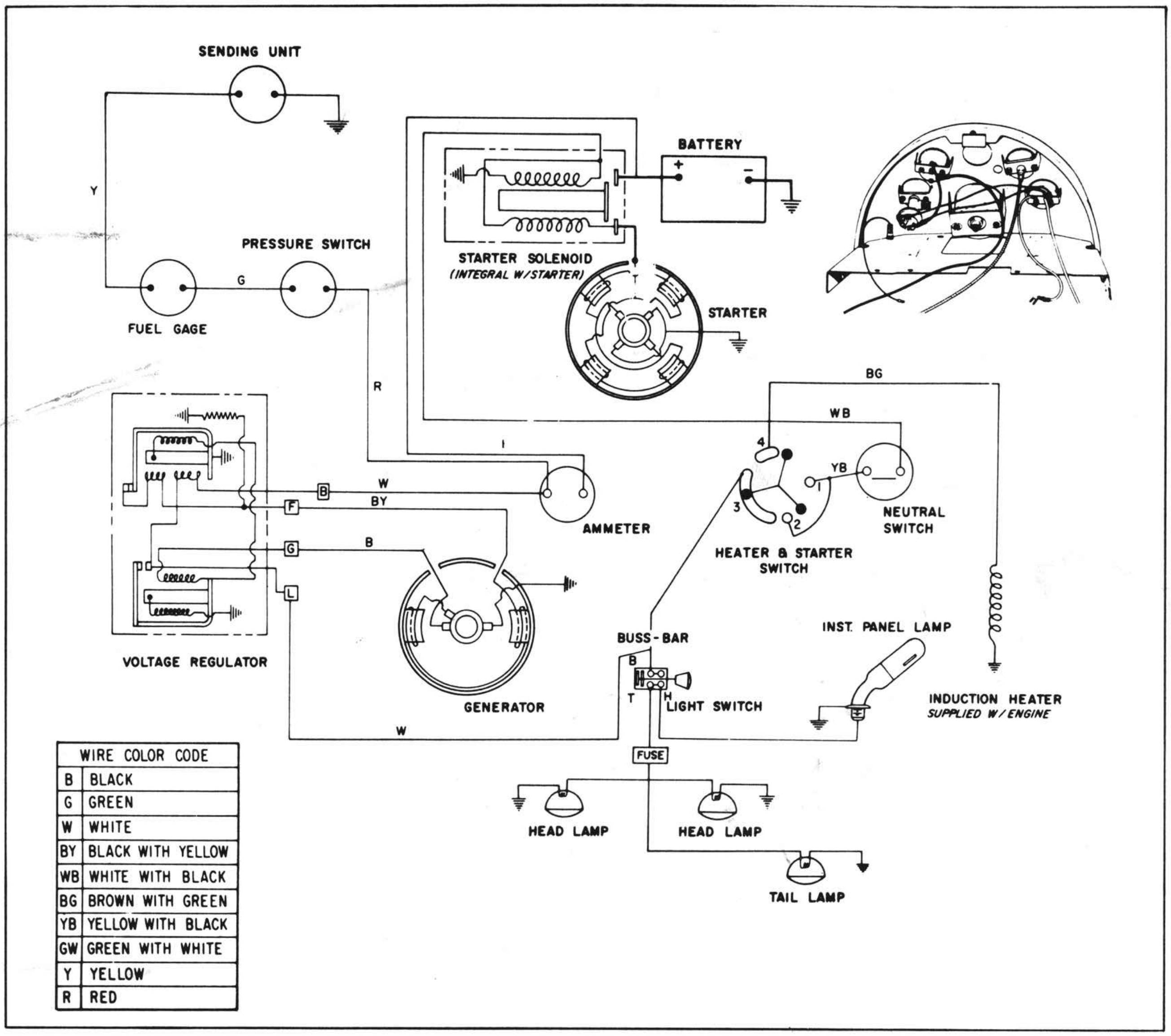
SENDING UNIT
Y
PRESSURE SWITCH
G
FUEL GAGE
BATTERY
+
-
STARTER SOLENOID
(INTEGRAL W/STARTER)
STARTER
R
BG
WB
I
4
YB
1
3
2
NEUTRAL SWITCH
HEATER & STARTER SWITCH
AMMETER
W
BY
B
F
G
L
B
VOLTAGE REGULATOR
GENERATOR
W
BUSS-BAR
B
T
H
LIGHT SWITCH
INST. PANEL LAMP
INDUCTION HEATER
SUPPLIED W/ENGINE
FUSE
HEAD LAMP
HEAD LAMP
TAIL LAMP

WIRE COLOR CODE	
B	BLACK
G	GREEN
W	WHITE
BY	BLACK WITH YELLOW
WB	WHITE WITH BLACK
BG	BROWN WITH GREEN
YB	YELLOW WITH BLACK
GW	GREEN WITH WHITE
Y	YELLOW
R	RED

Fig. 1 - Electrical System

BATTERY

The battery in the electrical system for the 4A/203 engine is a 12-volt, 96 ampere-hour lead-acid storage battery. It is a Willard, type CW-5SH, each of the six cells containing 17 plates. Its dimensions are: length 13-1/2", width 6-13/16", case height 8-9/32", overall height 9-9/32", or two 6-volt, 140 ampere hour lead-acid batteries. These are Willard type 3H-140, having 3 cells per battery, each with 19 plates per cell.

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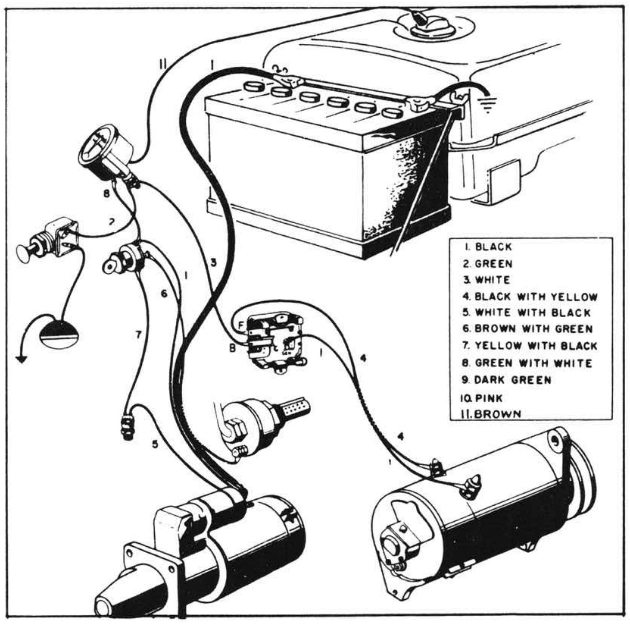

Fig. 1A - Wiring to Ammeter

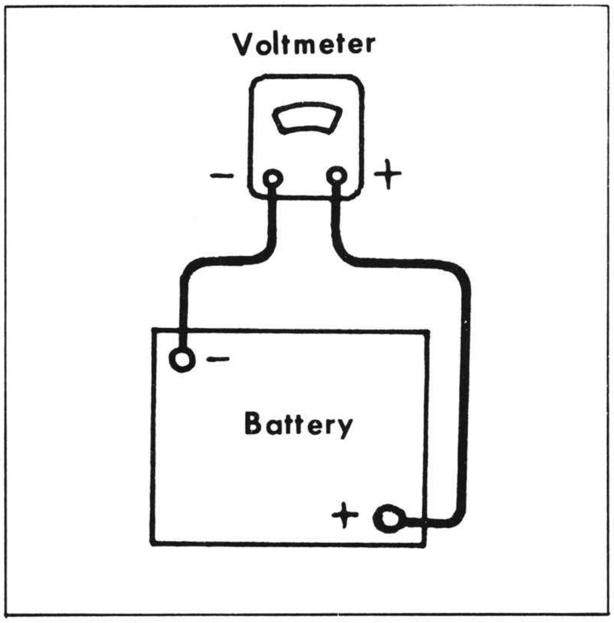

Fig. 2 - Battery Voltage Test

Their dimensions are 11-21/32" long, 7-1/16" wide, and 9-9/32" high. The rest of the specifications are very similar. Its normal charging rate is 8 amperes when attached to a bench charger. The hydrometer reading for this battery when fully charged is 1.260 S.G. at 80°F. The negative post of the battery is grounded.

TEST DATA

For details pertaining to testing and servicing this battery, refer to Group 1, Section A, Part 6.

WIRING SYSTEM

Fig. 1, shows a schematic drawing of the wiring system on the 4A-203 engine. This is a plan view of wiring connections to ammeter on the instrument panel.

Since there are no mechanically operated units (except the switches) in the wiring system, no maintenance is necessary. The only service that is necessary is to check the system periodically to be sure all connections are good and tight. The following illustrations and instructions describe the procedure for testing all circuits to determine whether the connections in the system are in first-class condition. In making these tests, accurate instruments should be used and the instrument's scale range should be sufficient to make accurate readings possible.

BATTERY VOLTAGE TEST, FIG. 2

1. Place fuel shut-off control rod in "off" position.

2. Connect voltmeter leads to each battery post.

3. Crank engine with starter for 10 to 15 seconds. Voltage should not drop below 10 volts.

If reading is low, check the voltage on each cell while starter is cranking the engine. Reading should be 1.6 volts or higher for each cell, and not vary more than .2 volts between cells. If the voltage drops below these specifications, it will have to be recharged or replaced before further tests can be accurately made.

BATTERY CABLE RESISTANCE TEST, FIG. 3 (INSULATED SIDE)

1. Connect positive voltmeter lead to positive battery terminal.

2. Connect negative voltmeter lead to terminal post on starter.

3. Place fuel shut-off control in "off" position.

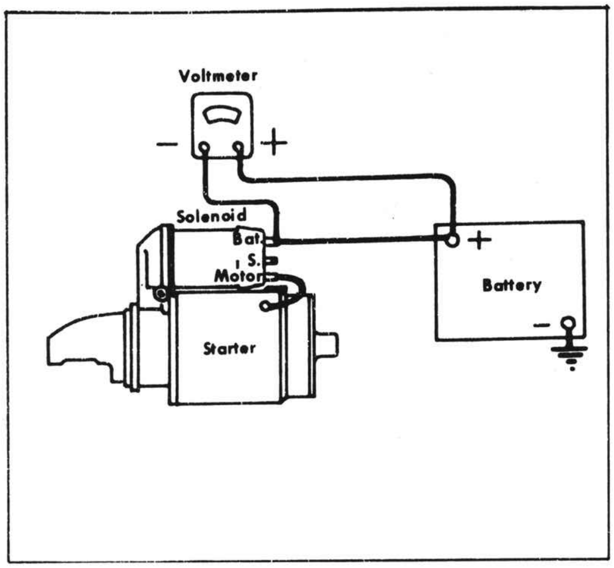

Fig. 3 - Battery Cable Resistance Test (Insulated Side)

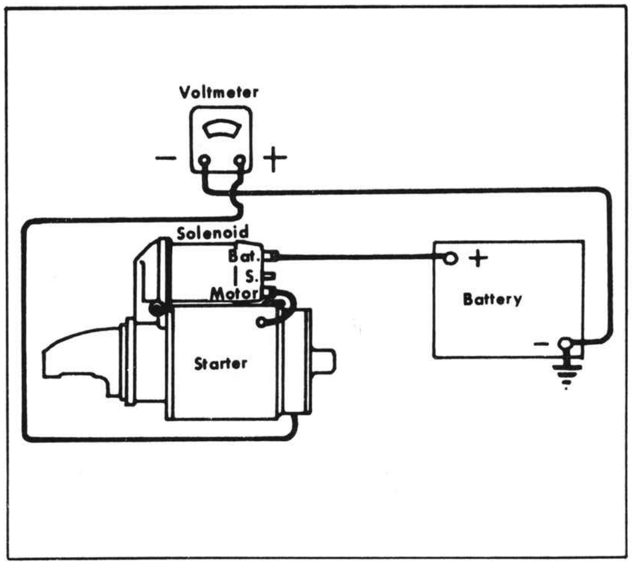

Fig. 4 - Battery Cable Resistance Test

4. With starter cranking engine, voltmeter reading should be .6-volt or less. If more than .6-volt, one of the cable connections is not good.

BATTERY CABLE RESISTANCE TEST, FIG. 4

1. Connect negative voltmeter lead to clamp on negative battery post.

2. Connect positive voltmeter lead to starter housing.

3. Place fuel shut-off control in "off" position.

4. With starter cranking engine, the voltmeter should read .6-volt or less. If more than .6-volt, ground connection between battery and tractor frame is not good.

SOLENOID SWITCH RESISTANCE TEST, FIG. 5

1. Connect positive voltmeter lead to cable from battery to solenoid.

2. Connect negative voltmeter lead to terminal post on starter.

3. Place fuel shut-off control in "off" position.

4. With starter cranking engine, the voltage reading should be .2 volt or less. If more than .2 volts, it indicates that either the connections to the solenoid are not good or the contact points inside the solenoid are not good. For repair of solenoid contact points, see Page 7.

STARTER SWITCH CIRCUIT RESISTANCE, FIG. 6

1. Connect positive voltmeter lead to the upper post on solenoid.

2. Connect negative voltmeter lead to "S" (small) terminal on solenoid.

3. Place fuel shut-off control in "off" position.

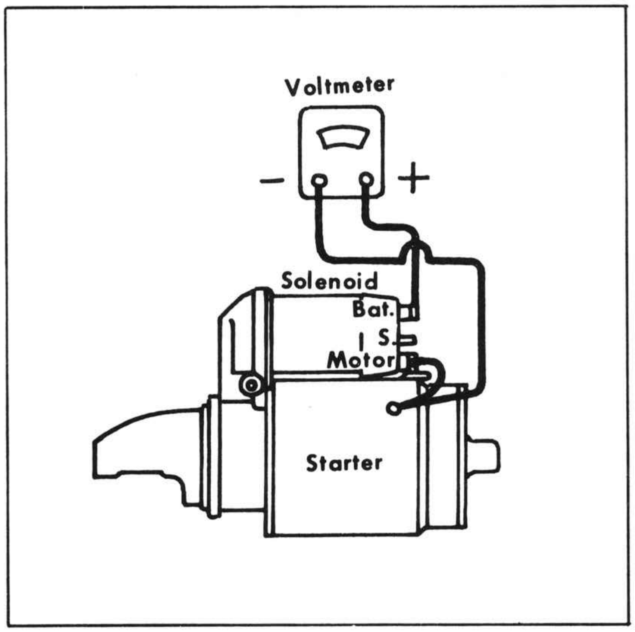

Fig. 5 - Solenoid Switch Resistance Test

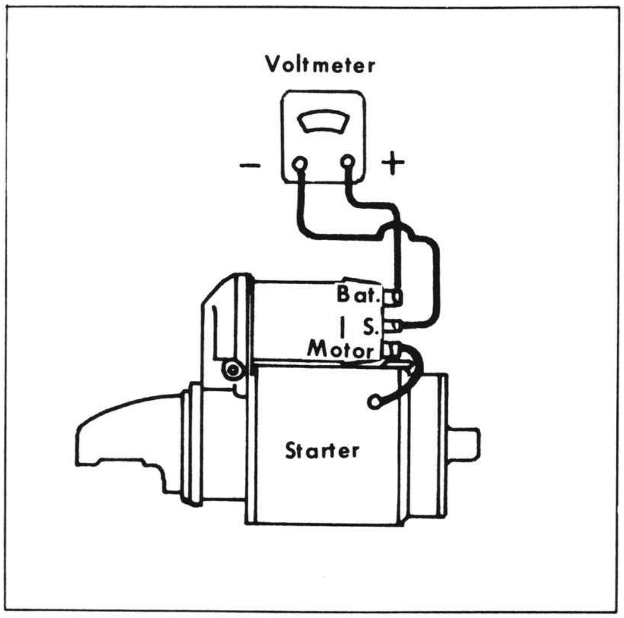
Voltmeter
-
+
Bat.
I
S.
Motor
Starter

Fig. 6 - Starter Switch Circuit Resistance

4. With starter cranking engine, the voltmeter should read .55 volts or less. If more than .55 volts, a bad contact exists either in the switch or wires from the switch to current supply or solenoid.

CHARGING CIRCUIT RESISTANCE TEST, FIG. 7

1. Disconnect the wire from the "BAT." terminal on the regulator and connect the positive lead on the ammeter to the "BAT." terminal on the regulator.

2. Connect one lead of a 7 OHM resistor to the wire just removed from the "BAT." terminal on the regulator and the other lead of the resistor to the negative lead on the ammeter.

3. Connect the positive lead on the voltmeter to the "A" terminal on the generator, and the negative lead to the positive post on the battery.

4. Ground the "F" terminal on the regulator with a jumper wire.

5. Start the engine and set the throttle lever at the speed that will show 10 amps on the ammeter.

6. The voltmeter should read .4 volt or less. If the voltmeter reads more than .4 volt, there is poor contact either at the ammeter on the tractor instrument panel, battery ground, or leads to the generator.

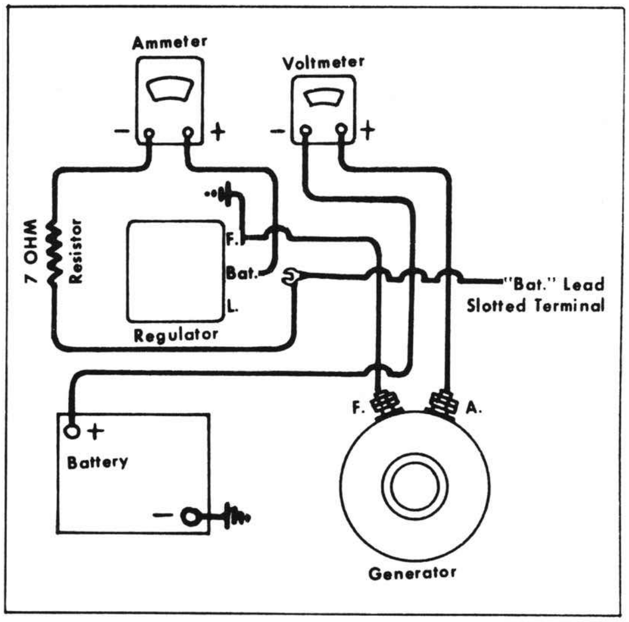
Ammeter
Voltmeter
-
+
-
+
7 OHM
Resistor
F.
Bat.
L.
Regulator
"Bat." Lead
Slotted Terminal
F.
A.
+
Battery
-
Generator

Fig. 7 - Charging Circuit Resistance Test

GENERATOR OUTPUT TEST, FIG. 8

1. Make same connections as shown in Fig. 7, except that the jumper wire grounding the "F" terminal on the regulator is to be removed and used to ground the "F" terminal on the generator and the negative lead on the voltmeter removed from the positive post on the battery and connected to the tractor frame or engine (grounded).

2. Start the engine and set its speed at full throttle.

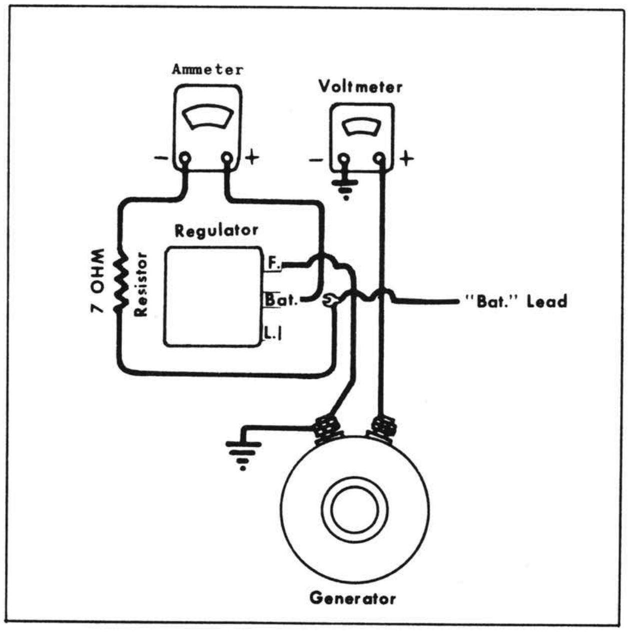
Ammeter
Voltmeter
-
+
-
+
Regulator
7 OHM
Resistor
F.
Bat.
L.
"Bat." Lead
Generator

Fig. 8 - Generator Output Test

3. The ammeter should read 10-12 amps and the voltmeter 14 volts for normal tractor operation. Refer to "REGULAR ADJUSTMENTS" on Page 14, of the Part for adjusting generator output to meet the requirements of various phases of tractor operation.

STARTER MOTOR

The starting motor on the 4A-203 engine is a Delco-Remy model 1108662 on engines prior to engine Serial No. 677170 and Delco-Remy model 1107503 on engine Serial No. 677170 and up. Both models are 12-volt, 4 pole, 4 brush starters. Two opposing brushes are grounded. The other two are interconnected and are in series with the motor's insulated terminal. The motor turns clockwise, viewing it from the drive pinion end.

Externally and mechanically the two starters are identical and interchangeable. Also the maintenance and service procedures are identical. The test procedures are also identical but the test specifications are different on some items. This manual will quote the specification for both series of motors in those cases when the specifications differ. If no separate specifications are quoted, those quoted apply to both starters.

An overrunning clutch type of drive is used to engage the starter drive pinion with the gear teeth on the engine flywheel. A solenoid switch, mounted on the starter, operates the overrunning clutch by means of a shift lever attached to the solenoid plunger. The solenoid is energized by a "starter switch" on the tractor instrument panel. The starter shaft and clutch have mating spinal splines which aid in matching the gear teeth. Electrical contact in the switch is synchronized with the shift lever in such manner that electrical contact for the starter circuit is not made until the gears are fully meshed. A coil spring on the solenoid plunger disengages the armature pinion when the starter switch is turned "off". The overrunning clutch protects the starter against excessive speed when the engine starts and before the above mentioned spring can disengage the pinion drive.

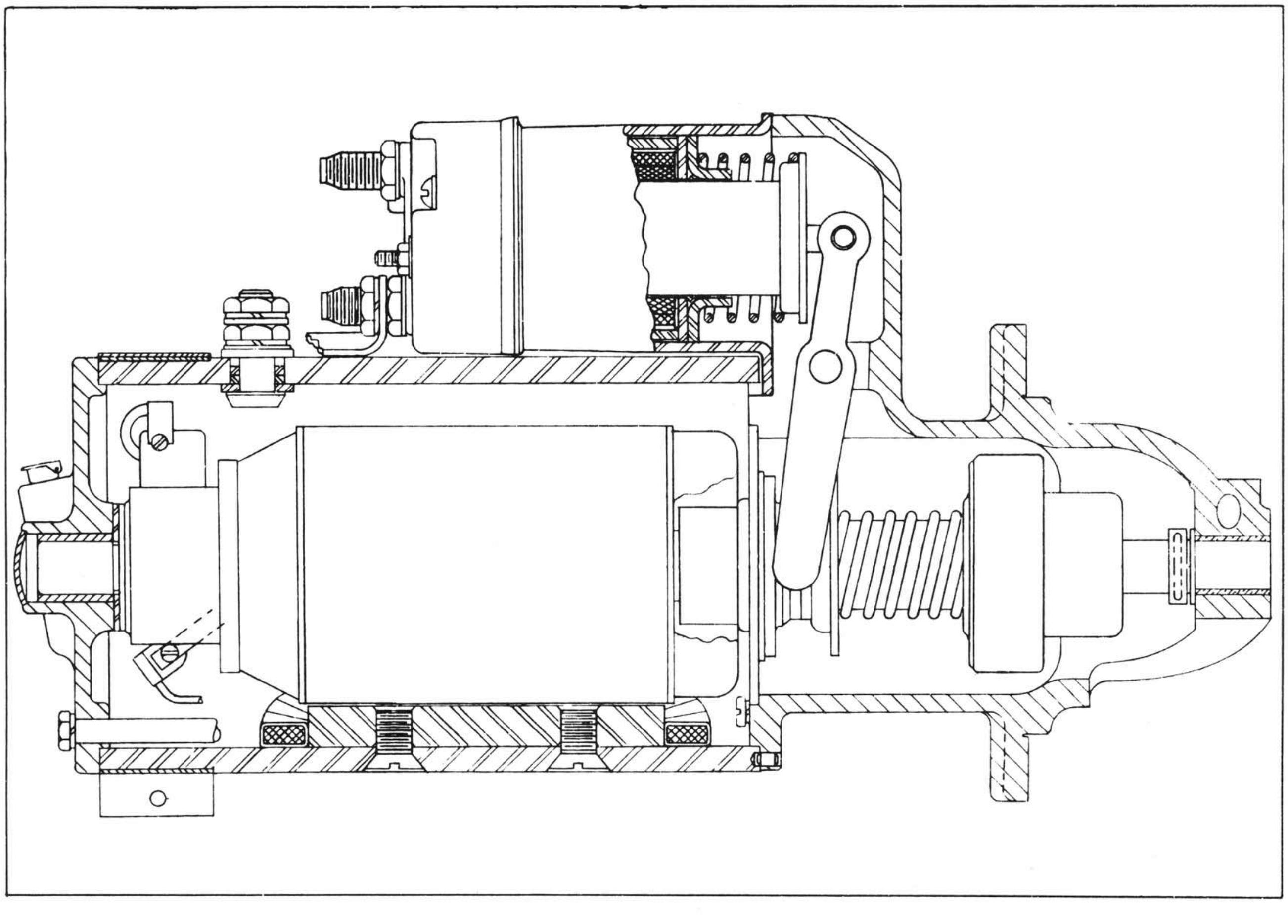

Fig. 9 - Starting Motor

MAINTENANCE

The only maintenance required on the starter is adding 8-10 drops of light engine oil to the oil cup on the outer bearing every 300 hours of operation. There is also an oil cup on the inner bearing. However, it being enclosed requires oiling only when the motor has been removed from the engine for further servicing.

INSPECTION

The battery and wiring system to the motor should be inspected and tested before servicing the motor. See Pages 1 and 7.

NO LOAD TEST

Remove the starter from the engine and put it in a vise or anchor it by some other suitable means. Connect its circuits to a fully charged 12-volt battery as shown in Fig. 10. (The "jumper" lead serves the same purpose as the starter switch on the tractor instrument panel and is to be attached last.)

The instruments should read as follows:

For Motor Model No. 1108662
Volts, 11.8
Amps., 40, minimum 70 maximum
Speed, 6800 RPM minimum, 9200 RPM maximum
For Motor Model No. 1107503
Volts, 11.8
Amps., 55 minimum; 85 maximum
Speed, 6300 RPM minimum, 8700 RPM maximum

If the instruments fail to meet these qualifications, (volts, amps or speed) it indicates that either the solenoid switch or the starter is at fault. To determine which is at fault, disconnect the "jumper" lead and move the ammeter and voltmeter leads from the upper post on the solenoid to the post (terminal) on the starter. If all three readings are then up to specifications, it shows that the solenoid is at fault and needs repair.

The following paragraphs outline a procedure for repairing the solenoid and the starter.

SOLENOID REPAIR

COIL TESTS

1. Disconnect the strap conductor between the solenoid and the starter terminal.

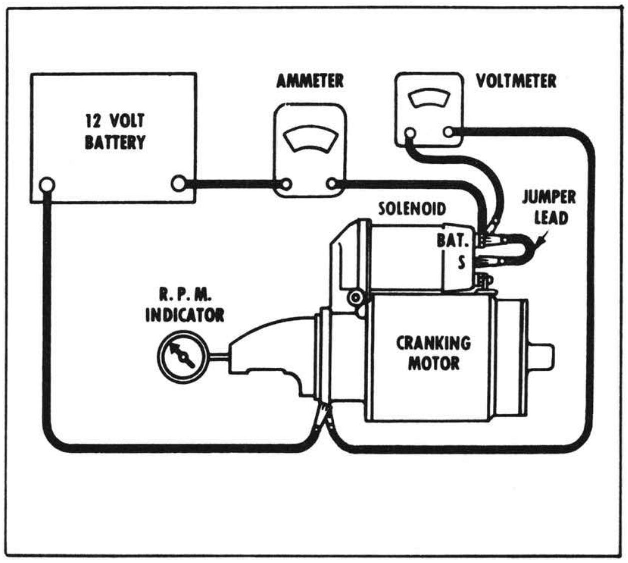

Fig. 10 - No Load Test

2. Remove the two screws holding the solenoid on the starter frame. Turn the solenoid a quarter turn to release retaining lip and the return spring will push the solenoid away from the housing.

3. Connect a voltmeter to the "S" (small) terminal and to the lower terminal on the solenoid.

4. Connect the negative post of a 12-volt battery to the lower terminal on the solenoid in series with an ammeter.

5. Connect the positive post of the battery to the "S" (small) post on the solenoid. The reading should be 47-54 amps and 10 volts.

6. Connect voltmeter to "S" terminal and to frame of solenoid.

7. Connect positive post of battery to "S" terminal on the solenoid in series with an ammeter, and the negative battery post to the frame of the solenoid. This reading should be 15.5 to 17.5 amps and 10 volts.

No readings on the instruments indicate broken or open circuits in the coil. Readings higher in amperage than those quoted in paragraph 5 and/or 7 indicate short circuited coil or coils. Readings lower, indicate too much resistance. In either event the coil assembly must be replaced.

If the readings are as specified in paragraph 5 and 7 but tests show the solenoid is defective,

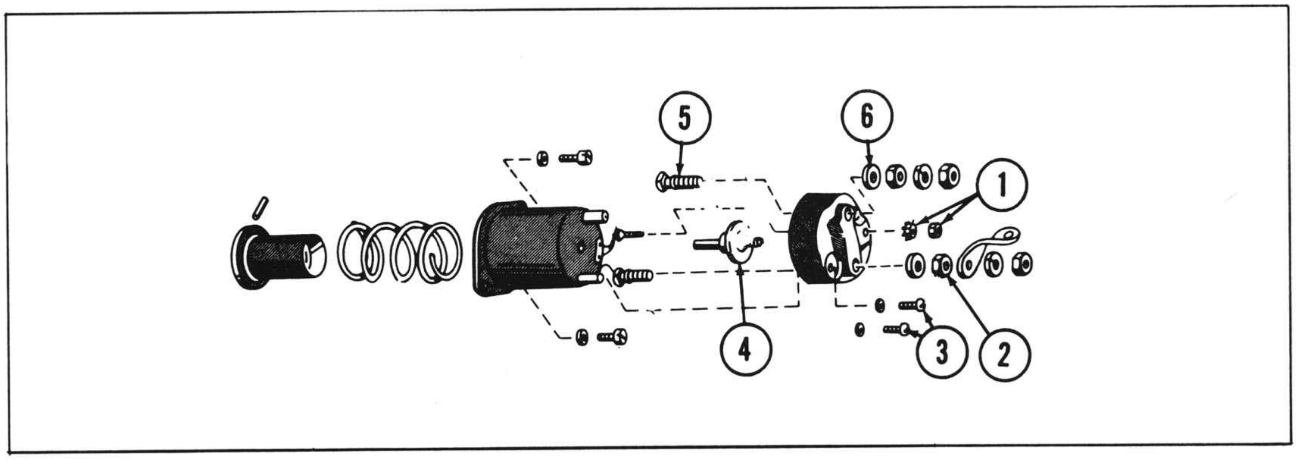

Fig. 11 - Solenoid Assembly

1. Nuts and washers
2. Nut on Terminal
3. Screws for Switch Cover
4. Contact Assembly
5. Terminal Contact
6. Washer

it indicates that the contact points in the solenoid are defective and will have to be replaced.

SOLENOID CONTACT POINTS

To inspect the condition of the contact points, requires disassembling the insulation cap off the end of the solenoid body. This should not be done unless there is positive evidence that the contact points are at fault. If such has to be done, extreme care must be exercised in every operation or the leads inside the assembly will be broken off the terminal posts.

DISASSEMBLY

1. Remove the nuts and washers, No. 1, Fig. 11, off the "S" terminal post and off the terminal post connecting the solenoid lead to the terminal on the starter, No. 2, Fig. 11. *Be careful not to twist either terminal post while screwing off the nuts.*

2. Remove the two screws holding the insulator cap on the solenoid and lift the cap off. *Be careful not to twist or bend the terminal posts while removing the cap or during subsequent handling of the unit.* Note also the position of the base of the terminal posts as they must fit properly in the grooves in the cap to avoid stressing the leads when the cap is being replaced. Failure to do so may break the leads. The contact assembly, No. 4, Fig. 11, can now be withdrawn.

REPAIR

If the contact disc is badly pitted or burned, the assembly will have to be replaced. If the contact post, No. 5, Fig. 11, is defective, it can be removed and replaced. (Dressing it with a file or stone is liable to make it too short.)

ASSEMBLY

Reassemble the parts by reversing the above described procedure of disassembly. New sealing washers, No. 6, Fig. 11, should be used. Also the area of contact between the insulator cap and the solenoid should be sealed with No. 2 Permatex or other similar sealer. Clean the surfaces before applying the sealer and wipe off any excess compound after the cap is secured in place.

After the assembly is completed, the solenoid should again be tested as outlined in paragraphs 3 to 7 under "COIL TESTS", Page 6. When replacing the solenoid on the starter, the area around the retaining lip and the starter body must be sealed.

STARTER REPAIR

To make any repairs on the starter, it is necessary to disassemble it. However, it should be disassembled only as far as is necessary to repair or replace those parts that are defective.

DISASSEMBLY

1. Remove the solenoid switch. See paragraphs 1 and 2, Page 7.

2. Remove the hinge bolt, No. 4, Fig. 12, for the shift lever.

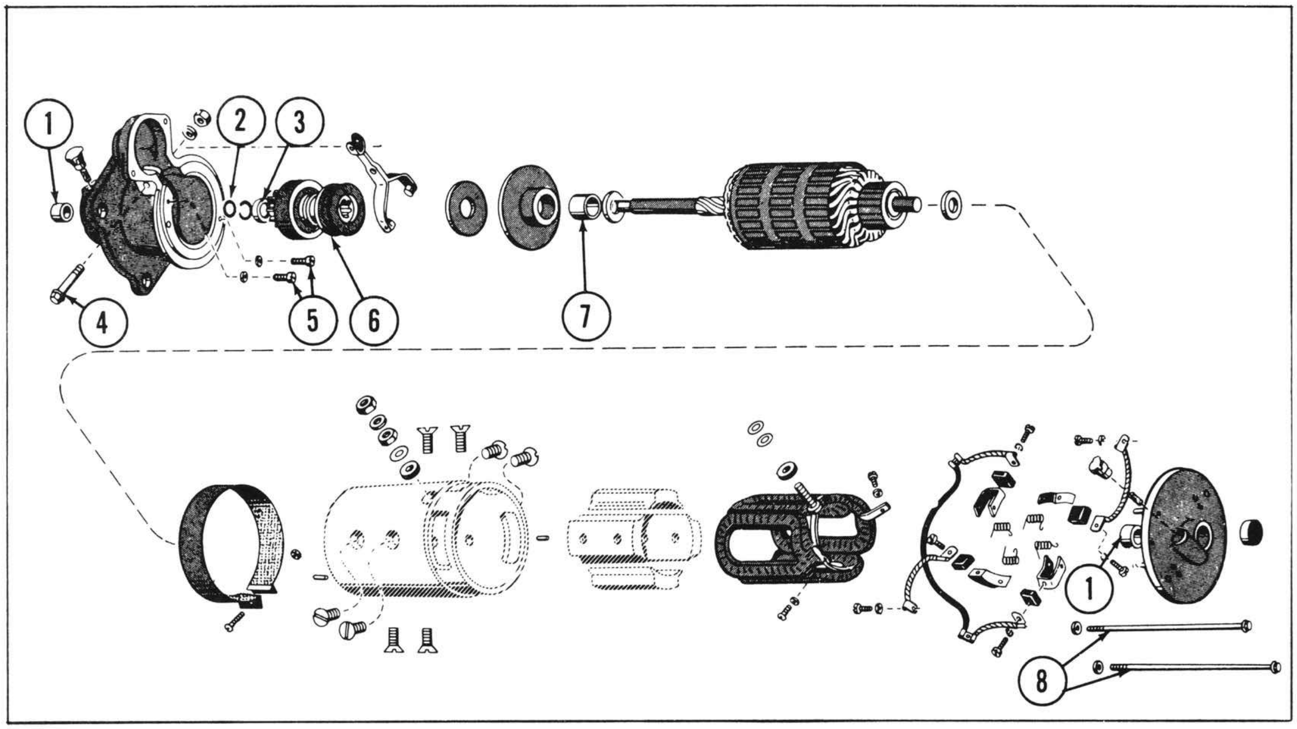

Fig. 12 - Starter Assembly

1. Bushing on Drive End
2. Thrust Washer
3. Pinion Stop Collar
4. Screw for Shift Lever
5. Screws
6. Drive Assembly
7. Bearing
8. Thru Bolts

3. Unscrew the two thru bolts from the commutator end plate, No. 8, Fig. 12.

4. Pull the drive end plate and armature out of the starter frame. Note the location of the dowel pins and holes.

5. Remove the two screws, No. 5, Fig. 12, holding the center bearing in the drive end plate. The end plate will now slide off the shaft.

6. Remove the thrust washer, No. 2, Fig. 12, off the shaft.

7. Place a suitable sleeve or cylinder against the snap ring retainer, No. 3, Fig. 12, and drive the retainer toward the armature and off the snap ring, see Fig. 13, and remove the snap ring.

8. Slide the drive assembly off the shaft. This will include the overrunning clutch and pinion assembly, fibre washer, center bearing assembly and spacer washer.

9. Disconnect the two field leads from the brush carriers and remove the end plate from the frame, note the dowel pin in the end plate and its mating hole in the frame.

INSPECTION

1. Inspect and test the armature and commutator as outlined in Group 1, Section A, Part 6.

2. Note condition of field coils for overheating or insulation deterioration. Replace if defective. If the coils have to be replaced, which requires removing the pole pieces, note the position and location of the pieces and the insulating paper, and when replacing, maintain their original position. The extended lip on the pole pieces must be toward the direction of rotation.

3. Test the coils for grounds with a test lamp and prods or with leads from a battery. If current flows between the starter terminal and the frame, one of the coils is grounded or the terminal post is grounded. Locate and insulate the ground if possible. If a coil or coils is grounded internally, they will have to be replaced.

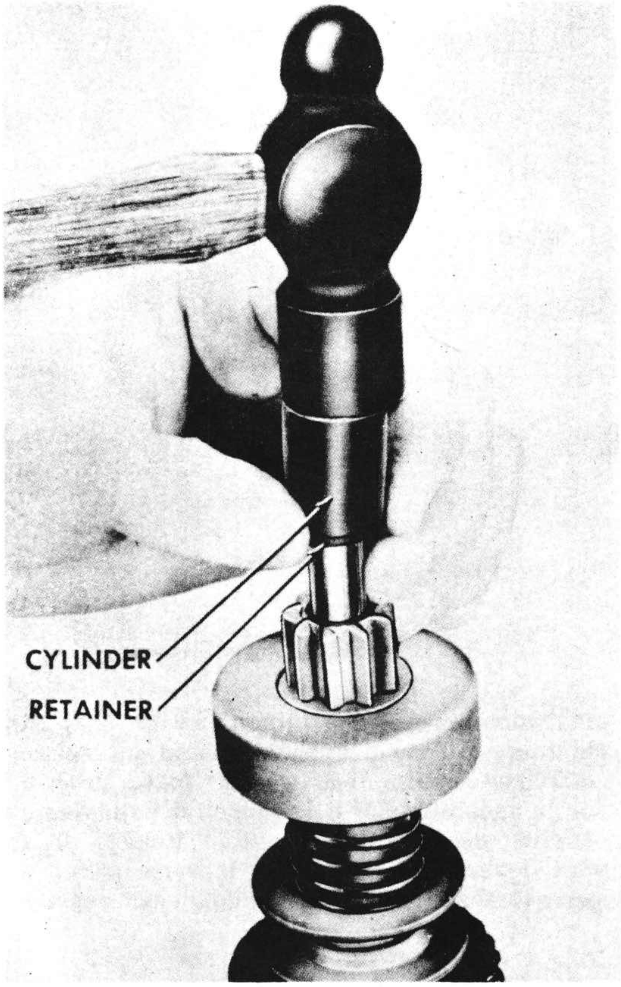

Fig. 13 - Removing Pinion Stop Collar

4. Check the coils for current flow. Current must flow between the terminal post and both the field coil leads.

5. Inspect the bronze bushings, No. 1, Fig. 12, in each end housing and the center bearing, No. 7, Fig. 12, for galling or excessive wear. Replace if necessary.

6. Check the teeth on the drive pinion and overrunning clutch assembly, No. 6, Fig. 12. Replace if necessary.

> *CAUTION: Do not wash the overrunning clutch with solvent. To do so may affect the lubricant inside the clutch. The clutch is lubricated at the factory and is good for the life of the unit if not contaminated. No provision is made for lubricating the clutch after factory assembly.*

7. Check the brushes for wear. If any brush is less than half as long as a new one, replace it. If a brush or brushes are replaced, they must be polished to fit the commutator.

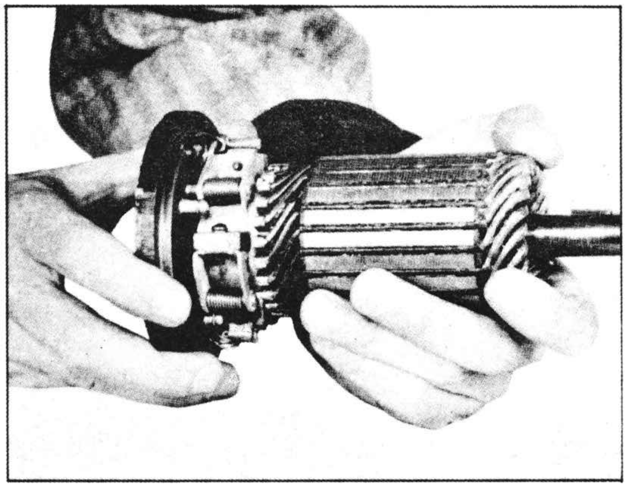

Fig. 14 - Fitting Starter Brushes

8. Place the commutator end plate on the armature and test the strength of the springs as shown in Fig. 15. The spring tension should be a minimum of 24 oz. Replace any weak spring.

REASSEMBLY

1. Clean the spiral splines on the pinion and clutch assembly with a clean cloth moistened with solvent. Wash the drive end of the armature shaft, center bearing and end plate in clean solvent. *Do not moisten the armature windings or the overrunning clutch or dip them in solvent.*

2. Oil the center bearing, No. 7, Fig. 12, and the splines on the shaft and pinion with light engine oil and replace all the parts on the drive end of the armature shaft in the same sequence as removed. See Fig. 12. Secure the snap ring and retainer in the snap ring groove in the shaft as shown in Fig. 16. The snap ring must be pressed into the groove in the retainer at the same time that it is compressed into the groove in the shaft as shown in Fig. 16.

3. Place the shaft assembly and the shifter fork in drive end frame in the same manner and position as removed. Secure the center bearing flange to the end frame with the two screws that held it in place, see No. 5, Fig. 12. Replace the hinge bolt supporting the shifter fork in the end frame.

4. Clean the commutator end of the shaft and the bushing in the commutator end plate, oil with light engine oil and place the end plate,

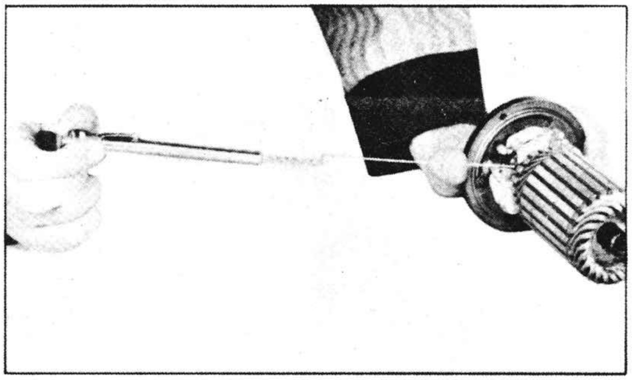

Fig. 15 - Testing Brush Spring Tension

on the frame. The brushes will have to be lifted enough to clear the commutator. Also note the alignment of the dowel pin.

5. Clean the contact surface between the field coil leads and the brush carriers and secure the leads to the brush carriers. Insert and tighten the thru bolts holding the end plates on the frame.

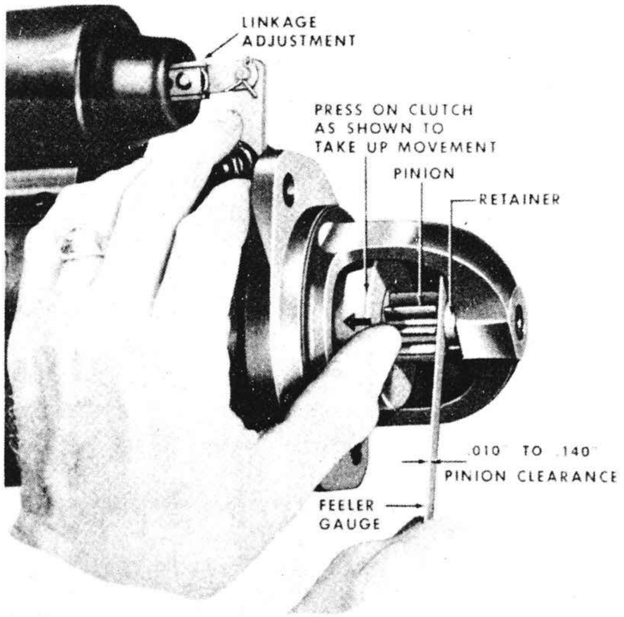
LINKAGE ADJUSTMENT
PRESS ON CLUTCH AS SHOWN TO TAKE UP MOVEMENT
PINION
RETAINER
.010" TO .140"
PINION CLEARANCE
FEELER GAUGE

Fig. 17 - Checking Pinion Clearance

6. Check the clearance between the pinion and the snap ring retainer as shown in Fig. 17. To do this connect a 6-volt battery to the starter as shown in Fig. 18. DO NOT USE A 12-VOLT BATTERY. (A 12-volt battery will cause the starter to operate.) This wiring circuit will energize the solenoid and cause it to shift the pinion into working position. With the pinion in working position, press the pinion inwardly as far as possible and measure the clearance between the pinion and the snap ring retainer. The clearance should be between .010" and .014". If it is less, there is an error in assembly. If it is more, it indicates excessive wear in the solenoid linkage or the shift lever yoke buttons. If these parts are worn to that extent, they should be replaced.

7. Add 8 to 10 drops of light engine oil to the hinged oil cups for the bearings and to test the starter as outlined on Page 8.

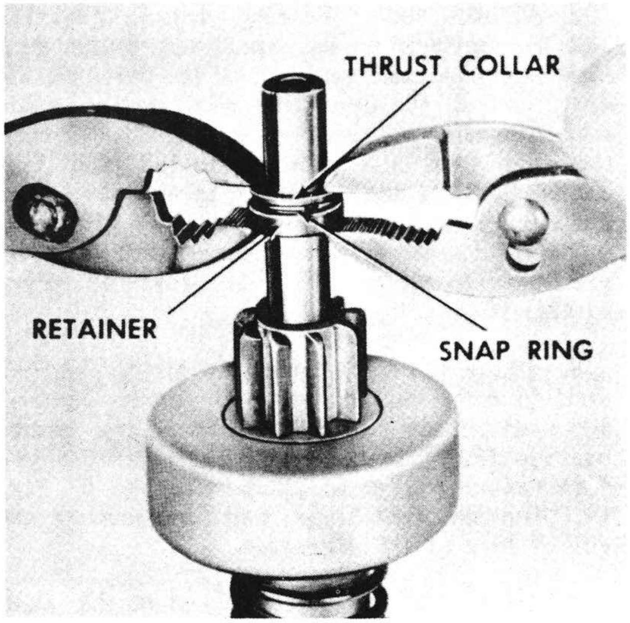
THRUST COLLAR
RETAINER
SNAP RING

Fig. 16 - Installing Snap Ring Retainer

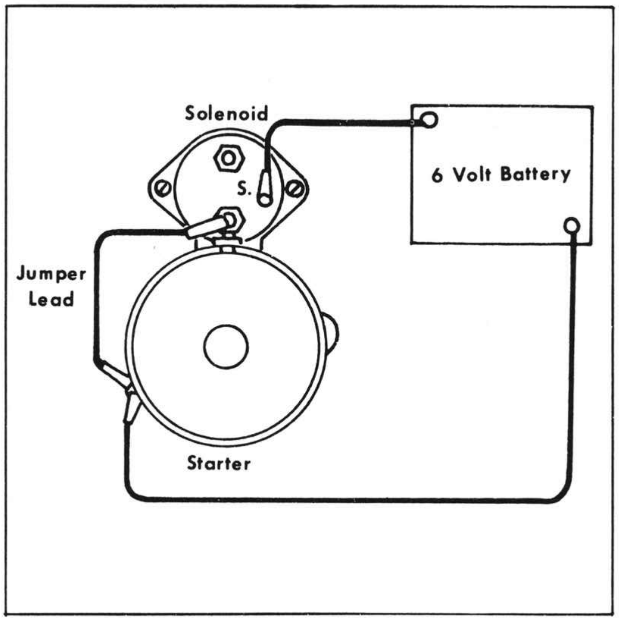
Solenoid
S.
6 Volt Battery
Jumper Lead
Starter

Fig. 18 - Circuit for Checking Pinion Clearance

GENERATOR

The generator on the 4A 203 engine is a Delco-Remy 3 brush-type, series 1101012. It is a 12-volt generator with a normal output of 10-12 amperes HOT. Maximum output is 25 amperes. It turns clockwise at approximately 2800 RPM at 1600 RPM engine speed.

The third brush is not adjustable. Current regulation is provided with a double unit regulator, which is mounted on the right side of the tractor just below the storage battery. For details pertaining to servicing this regulator and its further relation to the generator see Page 12, in this chapter.

Some factors involved in servicing the generator of all tractors are practically identical. Therefore, these factors will be covered in Group 1, Section A, Part 6. There are, however, some items that cannot be covered under this General Section because of slight variations in different models of generators. Such items that pertain to this particular model of generator will be discussed in the following paragraphs.

LUBRICATION

Each of the two generator bearings is provided with a hinge cap oil cup. These cups are to be filled with 8 to 10 drops of SAE 20 oil every 100 hours of operation. Care should be

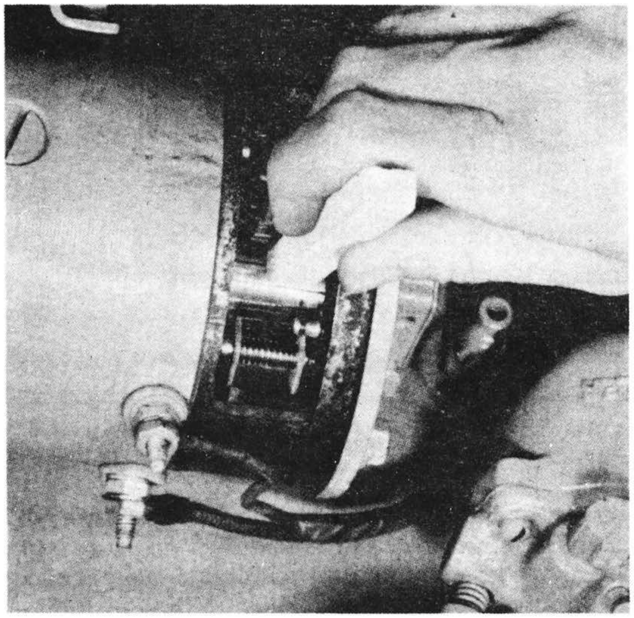

Fig. 20 - Fitting Generator Brushes

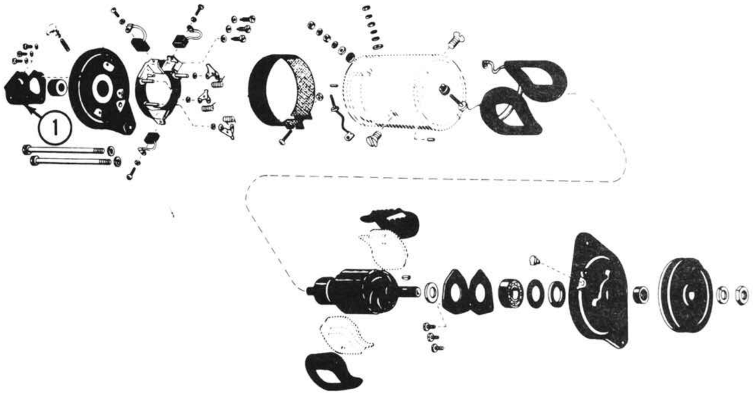

Fig. 19 - Generator Assembly

1. End Cover for Commutator

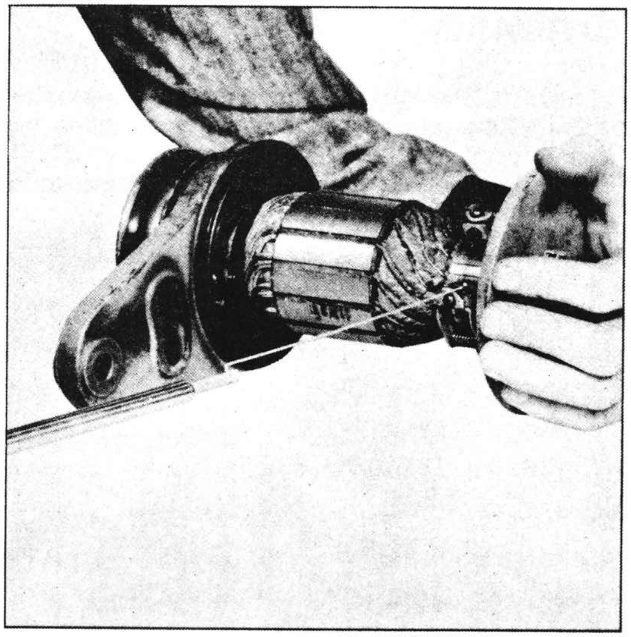

Fig. 21 - Testing Brush Tension

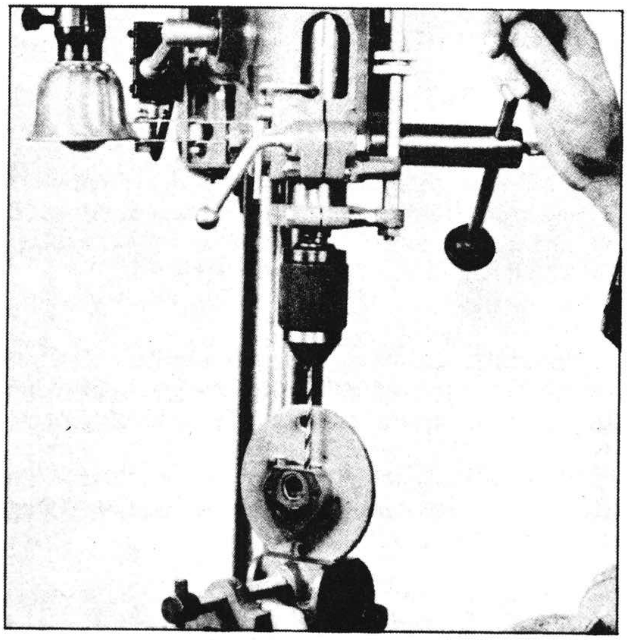

Fig. 22 - Drilling Bushing

taken to avoid excessive lubrication. Any excessive lubricant will develop an insulating film on the commutator and consequent reduction in generator output.

Do not lubricate the commutator. Do not oil the generator while it is running.

INSPECTION

For instruction on generator inspection, and tests, refer to Group 1, Section A, Part 5. If inspection discloses that the generator requires repair, remove it from the tractor and disassemble it.

DISASSEMBLY

1. Remove the cover band and disconnect the field wires from the third brush and the two coil wires from the main brushes.

2. Remove the thru bolts and slip the end plate off the commutator end of the generator.

3. Withdraw the pulley, end plate and armature assembly from the generator frame.

4. Unscrew the nut retaining the pulley on the armature shaft and press the pulley off the shaft, remove the key and spacer from the shaft and remove the armature from the end plate.

5. If the bearing in the pulley end plate is defective or worn, remove and discard it.

Check the armature and field coils, for short circuits, open circuits and capacity as outlined in Group 1, Section A, Part 5. The field current capacity of this generator is 2 to 2.14 amperes at 12-volts, 80°F.

REPAIR

If the commutator is rough or pitted, turn it down in a lathe and under cut the mica strips 1/32" deep. Always use the lathe chuck to center the armature shaft. *Do not use the center holes in the ends of the shaft.*

Compare the brushes with a new one. If they are less than half the length of the new one, replace them. New brushes must be seated to make sure that they make full contact with the commutator. To do this, tape a strip of 00 sand paper over the commutator, place commutator end plate on the commutator and rotate in the direction of rotation. See Fig. 14. Do not use emery cloth.

The brushes can be seated after the generator is assembled by applying a brush seating stone to the commutator as shown in Fig. 20. Move the stone back and forth across the commutator while the generator is running.

The brush seating stone will also clean a dirty commutator. Always blow the dust out of the area after seating brushes with a seating stone.

Slip the commutator end plate on the end of the armature and test the tension of the brush springs with a spring scale hooked to the brush attaching screw, as shown in Fig. 21. The main brush spring tension is 24 oz. The third brush spring tension is 19 oz. If the spring tension is below these specifications or if the springs show signs of overheating, replace them with new parts.

If the bushing in the commutator end plate is worn sufficiently to permit the end plate to "wobble" 1/4 inch or more when it is placed on the armature shaft, the bushing should be replaced. Before pressing out the worn bushing, remove the bearing cover, No. 1, Fig. 19, the oiler wick hole plug and the oiler wick.

The new bushing is slightly undersize to accommodate possible shaft wear and may have to be reamed to fit the shaft. Also, a hole will have to be drilled at an angle through the new bushing, after it is pressed into place to permit the oiler wick to pass through the side of the bushing and make good contact with the armature shaft. To drill this hole, use a 1/4 inch drill, cut a hole through the bushing, as shown in Fig. 22. Be sure sufficient bushing metal is cut out to permit the oiler wick to make good contact with the shaft. Clean the end plate and replace the wick, the plug, the bearing cover and gasket on the end plate. The wick and gasket should be replaced with new parts.

Clean the interior and the exterior of the generator frame using compressed air. Do not use a liquid solvent.

REASSEMBLY

1. Install the ball bearing and its related parts in the pulley end plate in the sequence as shown in Fig. 19, using a new felt washer and, if necessary, a new bearing.

2. Replace the end plate on the armature shaft and install the assembly in the generator frame.

3. Mount the commutator end plate on the generator frame and connect the internal wires to their respective brushes.

4. Mount the generator on the engine and replace the drive belt, adjusting it to proper tension as illustrated in Group 1, Section C, Part 5. Connect the wire conductors as laid out in Fig. 1, wiring diagram.

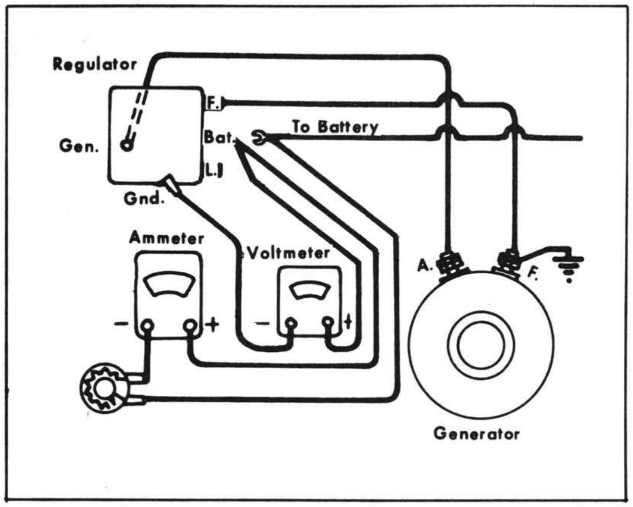

Fig. 23 - Testing Generator Output

CAUTION: The generator must be polarized before the engine is started. Failure to do so may result in burned relay points, a discharged battery or damage to the generator itself. To polarize the generator, connect an insulated jumper wire to the armature ("A") terminal on the generator and to the positive post of the battery. Leave the wire connected approximately 2 seconds, at the same time, tap the generator a few times lightly with a hammer.

After the brushes have been seated, blow all the dust from the generator.

After a generator has been repaired or brushes replaced, it should be tested for output capacity.

GENERATOR OUTPUT TEST

1. Remove the wire from the "BAT." terminal on the relay.

2. Attach the positive lead of an ammeter to the "BAT." terminal on the relay.

3. Attach the negative lead of the ammeter to one terminal or lead of a variable resistance.

4. Attach the other lead of the variable resistance to the wire that was removed from the "BAT." terminal on the relay.

5. Attach the positive lead of a 15-20 volt voltmeter to the "BAT." terminal of the relay and the negative lead to a suitable ground.

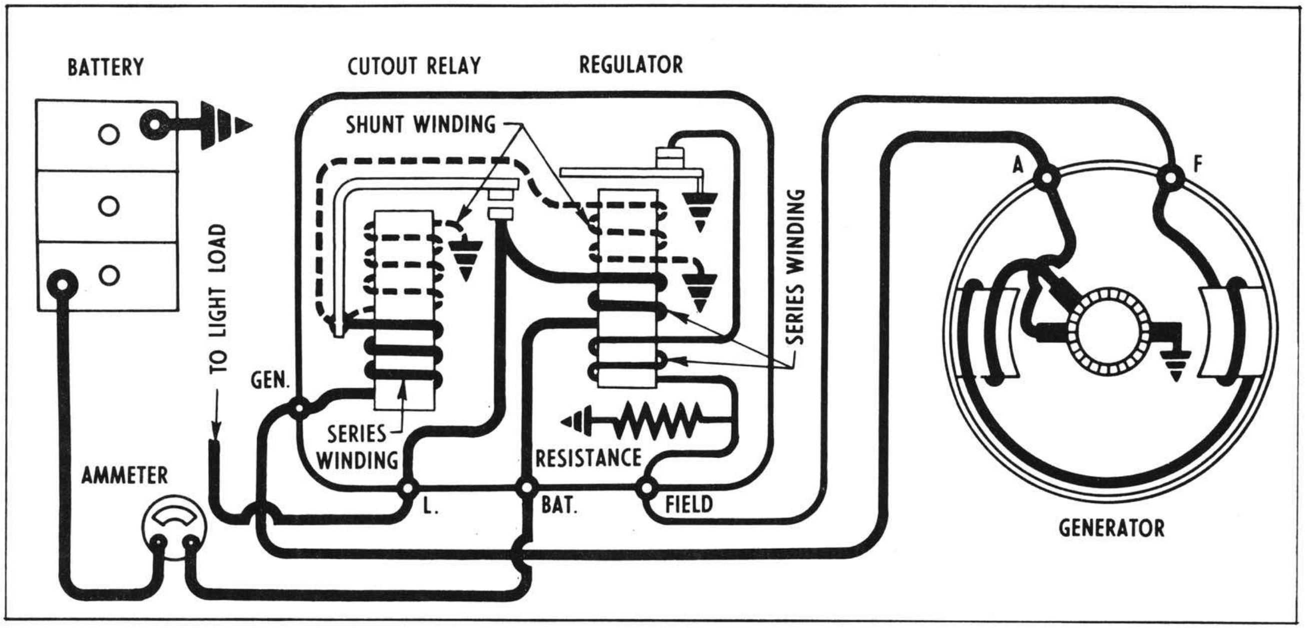

Fig. 24 - Regulator Circuit

6. Ground the "F" terminal on the generator with a jumper wire.

7. Start the engine and set its speed at 1600 RPM.

8. Turn the knob on the variable resistance until the volt meter reads 14V. The ammeter should read 10-12 amps when the generator reaches operating temperature, or after approximately 15 minutes operation.

If it does not, the voltage regulator needs readjusting or the generator was not properly repaired.

9. Remove the testing instruments and polarize the generator.

REGULATOR

The regulator for the electrical system on the 4A-203 engine is a Delco-Remy, series No. 1118981. It is a two-unit type.

One unit, the cutout is an automatic "switch" which disconnects the generator from the battery when the generator is not charging to prevent the battery from discharging back through the generator and automatically connects the generator to the battery when the generator is charging.

The other unit, a voltage regulator serves to increase or decrease the current flow from the generator to the system to compensate for varying needs such as varying engine speed, or a strong or weak battery. The regulator can be adjusted to increase or decrease the generator's capacity to meet the varying requirements of individual tractors such as those which make frequent starts and stops and vice versa, thus the battery can be protected against being either under charged or overcharged regardless of the status of tractor operation.

The voltage regulator also incorporates a temperature compensating device which allows a higher output when the regulator is cold and assists in reducing the output when the regulator becomes warm. This device is a bi-metal hinge on the regulator's contact point moveable arm (armature). This gives a quick charge to the battery immediately after the engine is started and consequent heavy drain on the battery.

The regulator is sealed against moisture and dust by means of a rubber gasket to seal the cover. If the cover is removed, care must be exercised when it is replaced to be sure this seal serves its purpose. However, the cover should not be removed unless it has been established that the regulator needs adjustment.

The regulator is negative grounded. Because of this and other characteristics, it is not acceptable to substitute this relay with one of another make or series. Also the current carried through the grounded circuit is very low.

Therefore, all ground connections or contacts between the relay base and the generator including the tractor frame, must be good (clean).

The two units of the relay-regulator are easily identified. The cutout relay is the unit on which, when not in operation, the contact points are held *open* by a coil spring under tension attached to the arm (armature) carrying one of the contact points. The voltage regulator is the unit on which the points are held *closed* when not in operation.

OPERATION

CUTOUT RELAY

A solenoid under the cutout relay armature contains two coils. One coil (shunt coil) is always in circuit with the generator. When the generator builds up enough voltage to equal slightly more than that of the battery, the magnetism generated by the shunt coil becomes strong enough to overcome the tension of the spring holding the points apart and the points are closed. This completes the circuit between the generator and the battery. The current which is now flowing from the generator to the battery passes through the other and heavier winding (series coil) on the solenoid which increases the magnetism sufficiently to hold the points tightly together thus assuring the points have sufficient capacity to carry the full load of the generator. This second winding serves another purpose. When the generator slows down or stops, the current in the battery starts to flow back to the generator through this coil in the opposite direction. This reverses the polarity of the solenoid because this second coil being heavier than the first mentioned coil, overcomes the magnetism of the first coil and the solenoid becomes "demagnetized" and the spring pulls the points apart. This disconnects or opens the circuit between the battery and the generator.

VOLTAGE REGULATOR (CIRCUIT "A")

The solenoid under the voltage regulator has three coils: one, a shunt winding (coil) that is in constant circuit with the generator; two, a series winding that carries current only when the cutout relay points are closed; three, a series winding through which the generator's field current passes only when the *voltage regulator points are closed*. This third winding is connected to the FIELD terminal on the generator and is wound around the solenoid in opposite direction to the first two coils, thus having the ability to create a magnetic field that opposes that of thefirst two mentioned coils. The purpose of this will be explained later.

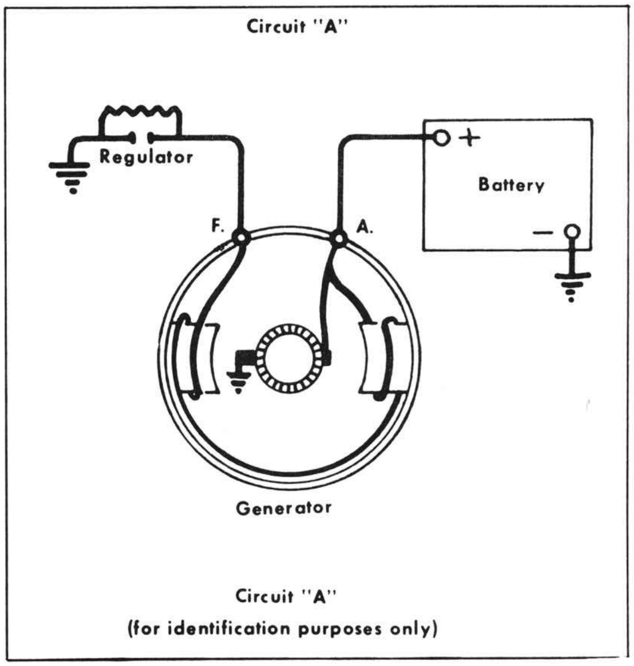

Fig. 25 - Adjusting Cut-Out Air Gap

When the generator goes into operation, the first coil, a light one and in constant circuit, creates a light magnetic field. When the cutout relay points close, the second coil a heavy one, increases the magnetic field. At the same time, the generator is flowing a current through its field coils by the way of the third coil and the voltage regulator points, thus building up a magnetic field in the generator field coils (poles). Naturally, the stronger the magnetic field in the generator field coils become, the greater is the generator output.

As the generator output increases, the magnetic strength of the regulator solenoid increases. When the generator output goes high enough, this magnetic field becomes strong enough to overcome the spring holding the points together and the points are opened. This breaks the generator's field coil circuit (partially so) which reduces the magnetic field in the generator and, in turn, reduces the generator output. This reduction in generator output, of course, reduces the strength of the magnetic field created by the first two coils and the spring on the armature pulls the points back together again and the generator field coils, in turn increase their magnetic field again. This then again, increases the generator output. This cycle is rapidly and continuously repeated as long as the generator and regulator are in operation. In

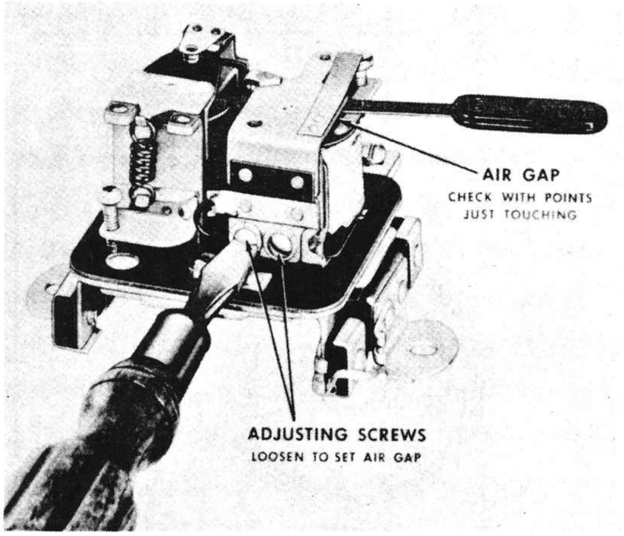

Fig. 26 - Cut-Out Adjustments

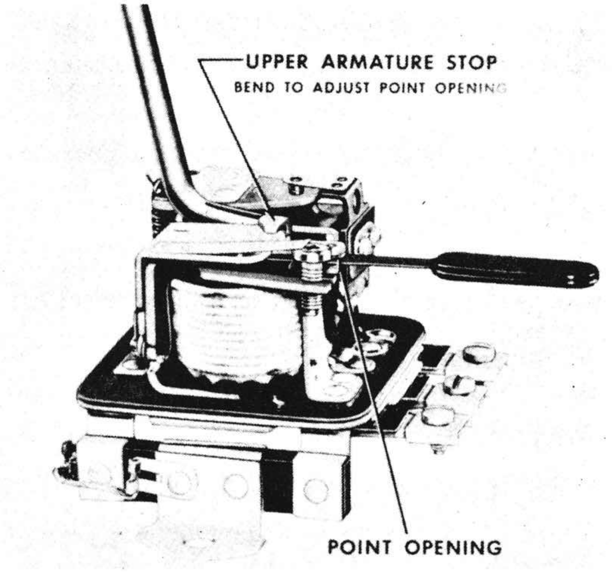

Fig. 27 - Cut-Out Point Opening

fact, this cycle is occurring 50 to 200 times a second, the speed of which determines the actual output of the generator. Increasing the speed of the cycling decreases generator output and vice versa. Therefore, increasing the spring tension on the arm increases generator output and vice versa.

As just stated, the third coil in the solenoid is wound in opposite direction to the first two coils, thus setting up a magnetic field in the solenoid in opposition to that of the first two coils. The purpose of this is to assist in "demagnetizing" the solenoid when the points are opened. Thus, the action of each cycle is more responsive and accelerated to a certain extent.

By studying the regulator wiring circuit in Fig. 24, it will be seen that a resistor is inserted in the generator's field circuit "ahead of" or shunting the voltage regulator points. This resistor permits a reduced flow of current through the generator's field coils while the regulator points are open during each cycle. Thus, the generator field coils are constantly activated but at a reduced rate while the regulator points are open.

This serves to maintain a constant but limited flow of current from the generator while the regulator points are open and also to protect the points from arcing excessively.

Since the resistance in the coils is lower when they are cold, current can pass through them more readily thus increasing the solenoid's magnetism or more readily overcoming the spring tension on the arm. Consequently, a hot regulator would increase generator output which would be undesirable in cases where few stops and starts are made. However to compensate for this the hinge for the arm is made of bi-metal which has some spring action when cold but little or none when hot.

This spring action assists the coil spring on the arm when the regulator is cold thus offsetting the increased magnetic strength of the solenoid to a certain extent. Therefore, a true reading of the generator's output cannot be made until the regulator is up to operating temperature and *the cover is in place.* Normally it requires about 15 minutes to bring the regulator up to operating temperature.

There are four terminals on the regulator, three protruding from the side and one on the underneath side of the base. The three on the side are marked "F" (field), "BAT." (battery) and "L" (line). The "F" terminal is connected

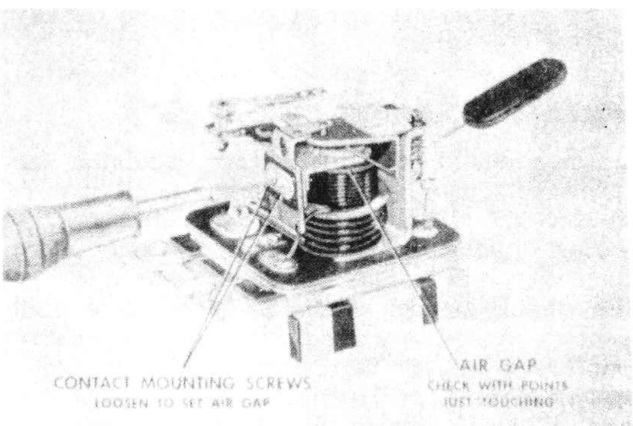

Fig. 28 - Voltage Regulator Air Gap

direct to the battery through the ammeter on the tractor instrument panel. The terminal under the base of the regulator is directly connected to the "A" terminal on the generator. Any line loads other than regular tractor equipment are to be connected to the "L" terminal, thus any change in line load will not affect the functioning of the regulator.

INSPECTION

Besides the electrical checks, all of which are allied with generator checks, the regulator also requires mechanical adjustments that go along with the electrical checks. They will be discussed and illustrated in the following paragraphs. These operations should be carried out before instituting any electrical checks or adjustments on either the generator or the regulator.

To make the mechanical adjustments, it is recommended that the regulator be removed from the tractor. If they are made without removal, the positive terminal must be removed from the battery.

CLEANING CONTACT POINTS

Due to their constant opening and closing while carrying an electric current, the points are exposed to arcing and consequent corrosion. In many cases regulator trouble and even generator output can be corrected by cleaning the points. A spoon or riffler file must be used because one of each pair of points is flat. A flat file cannot be successfully used on the flat point. NEVER USE SANDPAPER OR EMERY CLOTH. Dress the points sparingly as the points are of rather soft metal and cut rather rapidly. Also, file the points crosswise, not *lengthwise*.

It may be necessary to remove the adjustable point to dress the points in order to avoid bending their mountings due to file thickness. After the points are dressed, clean them with a lintless cloth moistened with carbon tetrachloride. Do not use gasoline or commercial solvent. (Some lighter fluids are acceptable.) After the points are cleaned, do not touch them with the bare hand.

CUTOUT AIR GAP

Adjust the air gap between the armature and the solenoid to .020" as illustrated in Fig. 26. Note that the armature is to be pressed down until the points just close when measuring the air gap.

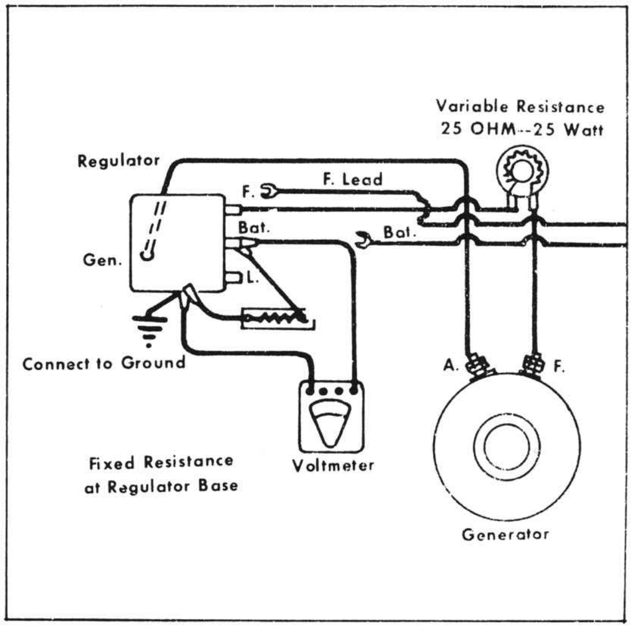

Fig. 29 - Voltage Regulator Setting Wiring Diagram

CUTOUT POINT OPENING

Adjust the point opening to .020" by bending the armature stop as illustrated in Fig. 27.

VOLTAGE REGULATOR AIR GAP

Press the voltage regulator armature down until the points just start to open and adjust the air gap between the armature and solenoid to .075" as illustrated in Fig. 28.

VOLTAGE REGULATOR UNIT SETTING

For normal tractor operation, the voltage regulator should be set to hold the generator voltage at 14.0 volts. However, to meet the varying phases of tractor operation the regulator may be set to hold the voltage at any point between 13.6 volts and 14.5 volts.

To test the voltage setting, place the regulator on the tractor *being sure the base of regulator makes a good ground contact with the tractor frame*. Connect a 7 OHM-12-volt fixed resistor from the "BAT" terminal on the regulator to the base of the regulator. Connect a 25 OHM-25 volt variable resistor to the "F" terminal on the terminal on the regulator and to the "F" lead from the generator. This resistor must have an open or "off" position at the extreme left end of the travel of its control. Connect an accurate reading voltmeter to the "BAT" terminal on the regulator and to the base of the regulator. These connections are illustrated in Fig. 29. To assure accuracy of set-

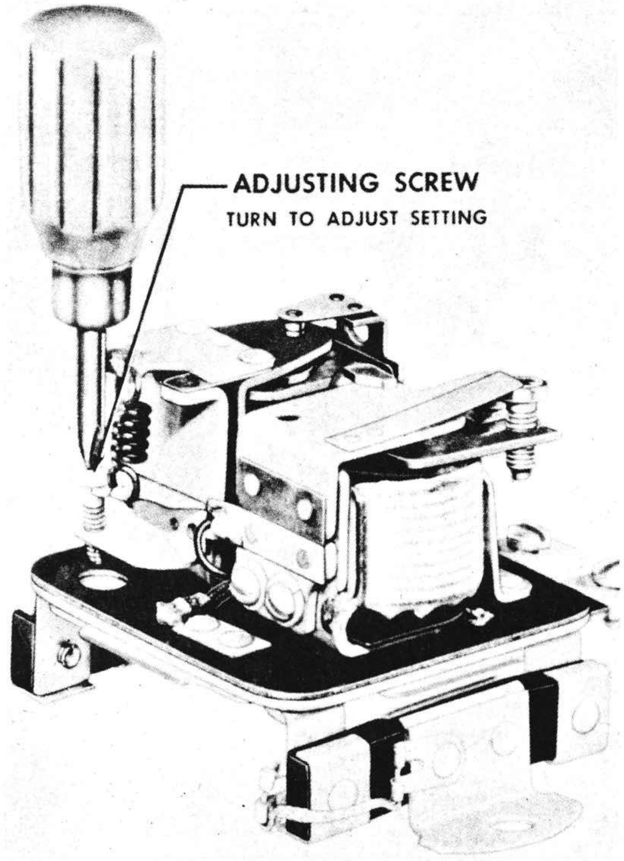
ADJUSTING SCREW
TURN TO ADJUST SETTING

Fig. 30 - Adjusting Voltage

ting, the regulator must be up to operating temperature. This means the engine must be run for 15 minutes at 1600 RPM with the above connections made and the variable resistor control to the extreme right or with the resistance all cutout.

After this warm up run is completed, and the engine running at 1600 RPM, slowly turn the variable resistor control to the left or until the resistor is open or "off" position. Then turn the control back to the right until all the resistance is cutout. Note the voltage reading. For normal tractor operation, the reading should be 14 volts when the variable resistor control is half way between each end of its travel. As above stated, normal is 14 volts but may be varied anywhere between 13.6 and 14.5 volts. If the storage battery does not stay fully charged or maintain a minimum of 1225 hydrometer reading, the voltage should be increased. If the battery is being overcharged (requires filling with water oftener than once every two weeks), the voltage should be decreased.

To increase the voltage, turn the armature spring tension adjusting screw clockwise (tighten the spring). To decrease voltage, turn the screw counterclockwise. See Fig. 30. After each screw adjustment, the regulator cover must be put in place to assure accurate instrument readings.

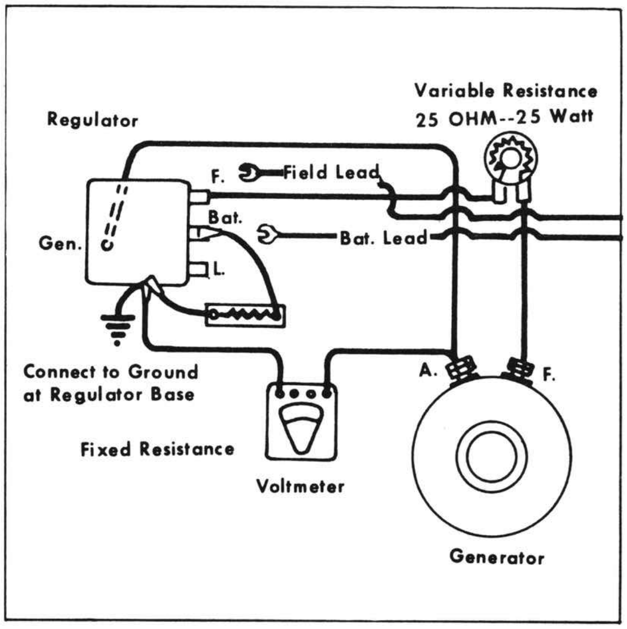
Regulator
Variable Resistance
25 OHM--25 Watt
F.
Field Lead
Bat.
Bat. Lead
Gen.
L.
Connect to Ground
at Regulator Base
Fixed Resistance
Voltmeter
A.
F.
Generator

Fig. 31 - Cut-Out Closing Voltage Wiring Diagrams

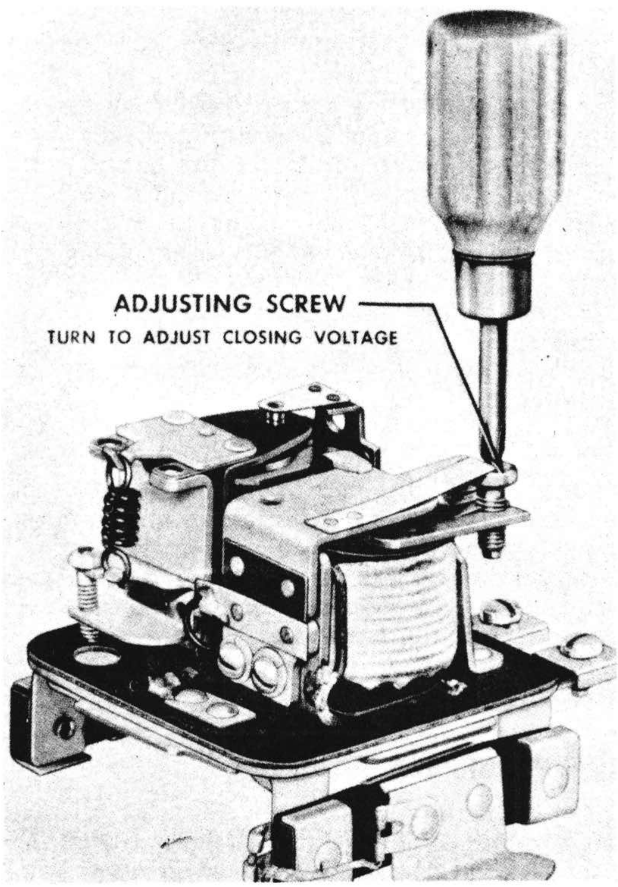
ADJUSTING SCREW
TURN TO ADJUST CLOSING VOLTAGE

Fig. 32 - Cut-Out Closing Voltage Adjustment

CAUTION: If the adjusting screw is turned down (clockwise) beyond normal range, it might bend the spring support so much that it will not return when the screw is turned out (counterclockwise). If such has occurred, turn the screw out far enough to permit bending the spring support back to its normal position.

CUTOUT CLOSING VOLTAGE

Immediately after the voltage regulator has been adjusted, the cutout closing voltage should be checked and readjusted if necessary. The normal cutout closing voltage is 12. 8 volts, but may vary within a range of 11. 8 to 14. 0 volts. To check the closing voltage make the same connections as illustrated in the disgram for checking the voltage regulator setting except that the voltmeter lead that was connected to the "BAT" terminal on the regulator is to be removed and connected to the "A" terminal on the generator as is illustrated in Fig. 31.

To check the closing voltage, turn the variable resistor control to the right until the resistance is all cutout, start the engine and run it at 1600 RPM. Slowly turn the resistor control to the left until the resistor is open, "off". Then slowly turn the control back to the right and at the same time watch the increase of the voltmeter reading. Turn the control slow enough to make the voltmeter reading increase slowly. When the voltmeter reading drops sharply, the points closed and the closing voltage is the voltmeter reading just before the reading dropped. If the reading is above or below 12. 8 volts, it should be adjusted. To increase the closing voltage increase the spring tension on the armature by turning the adjusting screw clockwise and vice versa to decrease the closing voltage. See Fig. 32.

INTAKE MANIFOLD HEATER (THERMOSTART)

For details pertaining to the function and operation of this unit, refer to Part 3, in this section under "THERMOSTART".

To test the electrical capacity of the heating element of the unit, disconnect the lead from the terminal, connect an ammeter in series with the terminal and the lead. Turn the starter switch on the instrument panel to the "H" position. The ammeter should read 16-18 amps.

LAMPS

Refer to Fig. 1, in this Part for the wiring circuit of the lamps and light switch. The bulb in both the headlamp and tail lamp are 12-volt, 35 watts, sealed beam, General Electric No. 4413 or 4419. Bulbs No. 4413 are for lamps in which the bulb is held with a clamping ring. Bulb No. 4419 is held in the lamp with a snap ring.

FUSE

The lamp circuit is protected with a 20 ampere buss-type fuse enclosed in a plastic sleeve which is located in front of the fuel tank. See the Owner's Manual for an illustration of its location.

TROUBLE SHOOTING

1. BATTERY OVERCHARGED

This will be indicated by the need for adding water to the battery at too frequent intervals. Unless there is an external leak, the battery should not require water oftener than every 100 hours of operation. Overcharging a battery will materially shorten its life. Reduce the charging rate as outlined under "GENERATOR OUTPUT". Reduce generator output by 1 volt.

If, by making this adjustment, the voltage cannot be reduced, the trouble may be:

a. Defective regulator unit.

b. Grounded generator field (in either generator, regulator or wiring).

c. The generator and battery leads may be interchanged at the regulator terminals.

To locate the trouble:

a. Disconnect the lead from the "F" terminal on the regulator, and run the engine at 1600 RPM.

If the generator output stops (ammeter on instrument shows "O") it indicates that the regulator is at fault and will have to be replaced or repaired.

b. The output remains high after test "A" indicates that the generator field circuit is grounded either in the generator or in the wiring. See "GENERATOR REPAIR" in this Part or check the wiring circuit.

c. Check the lead connected to the "L" and "BAT" terminals on the regulator. The lead or wire from the regulator to the ammeter on the instrument panel must go on the "BAT" terminal on the regulator.

2. BATTERY UNDERCHARGED

An undercharged battery will lose its capacity to take a charge or to produce its rated power before its normal life has expired.

Undercharging may be due to:

a. Loose connections or damaged wires.

b. Defective battery.

c. High resistance in wiring.

d. Low charging rate.

e. Defective regulator or generator.

To locate the trouble:

a. Check line losses as outlined under "WIRING SYSTEM" in this Part or remove and clean *every* connection between the battery and the generator, also the connections between the positive battery post and the ground on the tractor.

b. Check the capacity of the battery as outlined in Group 1, Section A, Part 6.

c. Connect the negative lead of a voltmeter to the positive post of the battery and the positive lead to the "BAT" terminal on the regulator. With the engine running and the tractor ammeter showing 2 to 4 amps, the voltmeter reading should not exceed 0.15 volt. Readings above 0.15 will indicate a bad connection or high resistance in the leads somewhere between the generator and the battery.

d. Increase the generator output by adjusting the regulator as outlined under "GENERATOR OUTPUT", in this Part for increasing generator output.

e. If conditions indicate that the charging rate is too low and the adjustment made for (d) above, does not improve performance, run the engine at 1200 RPM and momentarily ground the "F" terminal on the regulator. If this makes a strong increase in output, it indicates dirty regulator points on the voltage regulator unit or a defect in the unit. See "REGULATOR INSPECTION" for procedure for cleaning points. (Short circuiting the points will show whether they are dirty and not conducting a current.) If the points are O.K. and still no strong increase in output, it indicates that the generator is at fault. Refer to the paragraphs on "GENERATOR" in this Part.

If the generator shows no output, raise the engine speed to 1600 RPM, connect a jumper lead between the "A" terminal on the generator and the "BAT" terminal on the regulator. If this shows a generator output, remove the jumper lead from the "A" terminal on the generator and contact it with the terminal on the base of the regulator. If the generator still shows output, it indicates that the regulator is at fault and must be replaced or repaired by a specialist. If the generator still shows no output, the generator is at fault. Refer to the paragraphs on "GENERATOR" in this Part.

POLARIZING THE GENERATOR

Any time that the battery is charged, or connections removed from the regulator or generator, the generator must be polarized before the engine is started.

To polarize the generator, momentarily connect a jumper to the "A" terminal on the generator and to the "BAT" terminal on the regulator or to the positive post on the battery.

CAUTION: It is recommended that care be exercised not to touch the "F" terminal on the regulator with a "hot" wire or lead.

STARTER CRANKS ENGINE SLOWLY

If starter cranks engine slowly, the trouble may be:

a. Battery low or defective.

b. Resistance in circuit.

c. Starter switch defective.

d. Starter defective.

e. Cold weather and/or heavy engine oil.

To locate the trouble:

a. Test the battery with a voltmeter and a hydrometer. The hydrometer should read a minimum of 1200 for cold weather starting and 1.175 for warm weather starting. The battery should be recharged. Test the battery for capacity by cranking the engine 15 seconds with the fuel shut off. Battery voltage should not drop below 10 V. unless battery was low in charge when the test was started. If it was not, the battery's capacity (life) is questionable. See Group 1, Section A, Part 6 for more comprehensive test and proof of battery efficiency.

b. Check all connections on the heavy cable leads, i. e. battery posts, ground cable, starter and solenoid terminals. (Any bad connections can be detected by its getting quite warm during the test as outlined in (a) in the above instructions.)

c. Connect a heavy cable jumper ("00" size wire, 4 feet long) from the positive post on the battery to the terminal on the starter. If this restores cranking speed it indicates that the connections on the starters solenoid switch or the contacts in the switch are at fault. See Page 7 in this Part for solenoid switch servicing.

d. Armature shaft bearings may be at fault or dry. The commutator may be dirty. The brush springs may be weak or the brushes worn or sticking. See Page 7 for starter motor servicing.

e. Consideration must be given to starter cranking speed at temperatures below zero. Under these low temperatures, a good battery's capacity is reduced by 60% at this temperature plus the fact that the engine turns much harder particularly if it is new or just been overhauled. Consideration should be given to using lighter engine oil at these lower temperatures.

STARTER WILL NOT CRANK ENGINE

If the starter will not turn engine, the trouble may be:

a. Battery dead.

b. Cable connections to battery posts or ground dirty.

c. Solenoid switch contacts defective.

d. Starting motor defective or drive pinion broken or locked.

e. Engine locked.

To correct trouble:

a. Replace battery.

b. Connect a jumper lead from the positive post on the battery to the small "S" terminal on the solenoid. If engine cranks, the circuit from the battery, through the starter switch on the instrument panel to the "S" terminal on the solenoid switch is broken. Check the circuit with a voltmeter to locate the broken connection.

If the engine will not crank with the above mentioned jumper attached, short circuit the two large terminals on the solenoid switch. If the engine cranks, either the connections on the solenoid switch are defective or the solenoid switch is defective. Check the connections. If they are O.K., remove the solenoid switch and service it as outlined on Page 7.

d. If short circuiting the terminals on the solenoid switch does not crank the engine, attach a jumper cable ("00" size wire 4 feet long) from the "T" post on the battery to the terminal on the starter. If this cranks the engine, follow the instructions in the following paragraph, (e).

e. Remove cable connections to battery posts and clean them thoroughly. Replace and tighten them securely. Also remove the grounded end of the negative cable and clean its contact to the tractor ground thoroughly. Connect the negative lead of a voltmeter to the upper large terminal on the solenoid switch and the positive terminal to the starter frame. If the voltmeter does not read 12 V. the cable circuit is broken either at the battery post or in the cable. If the voltmeter reads 12 V., disconnect the cable from the upper terminal on the solenoid switch and touch it on the terminal on the starter. If the engine will not crank, the starter is defective and needs repair. See Page 8.

f. Test and correction are obvious.

PART 1—AD4.203 ENGINE SPECIFICATIONS

GENERAL DATA

Bore	3.6 inches
Stroke	5 inches
Number of Cylinders	4
Cubic Inch Displacement	203.5
Minimum Gross B. H. P.	55 @ 2000 RPM
Maximum Torque	158.5 ft.-lbs. @ 1200 RPM
Compression Ratio	18.5 to 1
Firing Order	1-3-4-2
Engine Speeds - MF 65 Tractors:	
Rated Engine Speed	2000 RPM (PTO speed of 720* RPM, or 635** RPM)
Low Idle Speed	575-625 RPM (PTO speed of 207-225* RPM, or 182-199** RPM)
High Idle Speed - No Load	2175 RPM (PTO speed of 783* RPM, or 691** RPM)

* - *Tractors with 1500 - 540 Transmission*
** - *Tractors with 1700 - 540 Transmission*

Tappet Setting	0.010 inch "hot", 0.012 inch "cold"

ENGINE OVERHAUL SPECIFICATIONS

Torque Tensions

Cylinder Head	55-60 ft.-lbs.
Connecting Rods:	
Early Unplated Nuts	65-70 ft.-lbs.
Later Cadmium-Plated Nuts	45-50 ft.-lbs.
Main Bearings:	
Engines without Shim Washers between Setscrew Heads and Locks	110-120 ft.-lbs.
Engines with Shim Washers between Setscrew Heads and Locks	90-95 ft.-lbs.
Flywheel	75 ft.-lbs.
Water Pump Pulley	55-60 ft.-lbs.
Oil Filter Bowl	15-20 ft.-lbs.

Pistons

Pistons Used with Chrome-Plated Liners:	
Piston Diameter: (measured at right angles from piston pin)	
Top Piston Skirt Diameter	3.5919 - 3.5929 inches
Bottom Piston Skirt Diameter	3.5955 - 3.5965 inches
Piston Pin Bore Diameter	1.24975 - 1.250 inches
Piston Height at T. D. C. Relative to Top Face of Cylinder Block	0.0015 - 0.008 inch above
Pistons Used with Cast Iron Cylinder Liners:	
Piston Diameter: (measured at right angles from piston pin)	
Top Piston Skirt Diameter	3.5915 - 3.5929 inches
Bottom Piston Skirt Diameter	3.5955 - 3.5965 inches
Piston Pin Bore Diameter	1.24975 - 1.250 inches
Piston Height at T. D. C. Relative to Top Face of Cylinder Block	0.0015 - 0.008 inch above

Cylinder Liners

Chrome-Plated Cylinder Liners:	
Inside Diameter of Liner	3.6015 - 3.6025 inches
Outside Diameter of Liner	3.6875 - 3.6885 inches
Cylinder Block Bore	3.6875 - 3.6885 inches
Location of Liner Flange below Top Face of Block	0.001 - 0.009 inch
Cast Iron Cylinder Liners:	
Inside Diameter of Liner	3.6015 - 3.6025 inches
Cylinder Block Bore	3.6875 - 3.6885 inches
Outside Diameter of Liner	
Service Liners	3.6875 - 3.6885 inches
Production Liners	3.6895 - 3.6905 inches
Cylinder Liner Fit	
Service Liners	From minus 0.001 to plus 0.001 inch clearance
Production Liners	From minus 0.001 to minus 0.003 inch clearance
Location of Cylinder Liner Flange below Top Face of Block	0.000 to 0.004 inch below

Piston Pins

Pin Diameter	1.24975 - 1.250 inches
Clearance in Connecting Rod Bushing	0.0005 - 0.00175 inch
Clearance in Piston Pin Bore	Minus 0.00025 to plus 0.00025 inch

Piston Rings

Ring Side Clearance (one piece rings):	
New Compression Rings (plain and taper faced)	0.0019 - 0.0039 inch
New Oil Rings	0.002 - 0.004 inch
Ring Gap Clearance (one piece rings):	
Compression Rings (plain and taper faced)	0.009 - 0.013 inch
Oil Rings	0.009 - 0.013 inch

(Ring Gap Clearance Measured in a 3.60 Inch Bore)

Connecting Rods

Connecting Rod Bore Diameter (bushing end)	1.37475 - 1.3762 inches
Inside Bushing Diameter (finished)	1.2505 - 1.2515 inches
Connecting Rod Bore Diameter (bearing end)	2.3950 - 2.3955 inches
Bearing Clearance	0.0025 - 0.004 inch
Rod Side-Play	0.0095 - 0.0133 inch

Crankshaft and Main Bearings

Crankpin Journal Diameter	2.2485 - 2.249 inches
Main Bearing Journal Diameter	2.7485 - 2.749 inches
Block Bore Diameter (main bearings)	2.9165 - 2.9175 inch
Main Bearing Clearance	0.003 - 0.005 inch
Crankshaft End-Play	0.002 - 0.014 inch

Valves

Valve Head Diameter:	
Intake	1.532 - 1.536 inches
Exhaust	1.313 - 1.317 inches
Stem Diameter (intake and exhaust)	0.311 - 0.312 inch
Stem Clearance Limits (intake and exhaust)	0.002 - 0.0045 inch
Face Angle (intake and exhaust)	44 degrees
Valve Interference Angle (intake and exhaust)	1 degree (valve face 44 degrees and valve seat 45 degrees)
Minimum Margin (intake and exhaust)	1/32 inch
Tappet Setting (intake and exhaust)	0.010 inch (hot), 0.012 inch (cold)
Valve Head Clearance below Face of Cylinder Head Clearance Limits (intake and exhaust)	0.070 - 0.140 inch below face

Valve Seats (Intake and Exhaust)

Seat Angle	45 degrees
Seat Contact Width	1/16 inch
Maximum Seat Runout	0.002 inch

Valve Guides (Intake and Exhaust)

Inside Diameter	0.314 - 0.3155 inch
Clearance Limits (stem-to-guide)	0.002 - 0.0045 inch
Guide Height above Top Face of Cylinder Head	0.584 - 0.594 inch

Valve Springs (Intake and Exhaust)

Inner Spring:	
Approximate Free Length	1-3/8 inches
Spring Length Valve Closed	1-3/16 inches
Spring Pressure @ 1-3/16 Inch Length	7 - 9 lbs.
Spring Length Valve Open	27/32 inch
Spring Pressure @ 27/32 Inch Length	21 - 25 lbs.
Outer Spring:	
Approximate Free Length	1-25/32 inches
Spring Length Valve Closed	1-1/2 inches
Spring Pressure @ 1-1/2 Inch Length	21-25 lbs.
Spring Length Valve Open	1-5/32 inches
Spring Pressure @ 1-5/32 Inch Length	48-52 lbs.

Valve Tappets

Tappet Stem Diameter	0. 6225 - 0. 62375 inch
Tappet Bore in Cylinder Head	0. 6245 - 0. 62575 inch
Clearance Limits	0. 00075 - 0. 0035 inch

Rocker Arm Shaft Assembly

Rocker Arm Shaft Diameter	0. 62225 - 0. 62375 inch
Inside Bushing Diameter (rocker arm)	0. 6245 - 0. 62575 inch
Clearance Limits (shaft-to-bushing)	0. 00075 - 0. 0035 inch

Valve Timing (Crankshaft Degrees)

Intake Valve Opens	13 degrees B. T. D. C.
Intake Valve Closes	43 degrees A. B. D. C.
Exhaust Valve Opens	46 degrees B. B. D. C.
Exhaust Valve Closes	10 degrees A. T. D. C.

Timing Gears

Timing Gear Backlash (all except oil pump)	0. 003 - 0. 006 inch
Idler Gears and Hubs:	
Hub Diameters (upper and lower)	1. 996 - 1. 997 inches
Upper Idler Gear Bore	1. 9998 - 2. 0007 inches
Inside Bushing Diameter (lower idler gear)	1. 9998 - 2. 0007 inches
Clearance Limits - Idler Gear to Hub	0. 0028 - 0. 0047 inch
Idler Gear-End-Play	0. 002 - 0. 004 inch

Camshaft

Front Bearing Journal Diameter	1.869 - 1.870 inches
Front Bearing Bore Diameter	1.874 - 1.877 inches
Center Bearing Journal Diameter	1.859 - 1.860 inches
Center Bearing Bore Diameter	1.864 - 1.867 inches
Rear Bearing Journal Diameter	1.839 - 1.840 inches
Rear Bearing Bore Diameter	1.844 - 1.847 inches
Bearing Clearance Limits (journal-to-bore)	0.004 - 0.008 inch
Cam Lift	0.3085 - 0.3165 inch
Camshaft End-Play	Controlled by a thrust plate in the cylinder block
Thrust Plate Thickness	0.125 - 0.130 inch
Thrust Plate Location	0.008 inch in front to 0.003 inch below face of block

FUEL AND AIR SYSTEM SPECIFICATIONS

Diesel Fuel Oil (American Society of Testing Materials Specifications)

LIMITING REQUIREMENTS FOR DIESEL FUEL OILS
ASTM Designation: D975-59T

Grade of Diesel Fuel Oil	Flash Point, deg. Fahr. Min.	Pour Point, deg. Fahr. Max.	Water and Sediment, percent by volume Max.	Carbon Residue on 10 percent Residuum, percent Max.	Ash, percent by weight Max.	90% Distillation Temperatures deg. Fahr.		Viscosity at 100° F. Kinematic, Centistokes (or Saybolt Universal sec.)		Sulfur, percent by Weight Max.	Copper Strip Corrosion Max.	Cetane Number Min.
						Min.	Max.	Min.	Max.			
No. 1-D Winter Operation	100 or legal		Trace	0.15	0.01		550	1.4	2.5 (34.4)	0.50	No. 3	40
No. 2-D Summer Operation	125 or legal		0.10	0.35	0.02	540	675	2.0 (32.6)	5.8 (45)	1.0	No. 3	40

For cold weather operation the pour point should be specified 10 F. below the ambient temperature at which the engine is to be operated.

Low-atmospheric temperatures as well as engine operation at high altitudes may require use of fuels with higher cetane ratings.

Fuel Tank - MF 65 Tractor

Capacity	17 U.S. gallons

Fuel Lift Pump

Operating Pressure	5-8 lbs. p.s.i.

Fuel Injection Pump - MF 65 Tractor

Make and Model No.	C.A.V. DPA type, No's. 3240428, 3240458 and 3240698
Injection Pump Static Timing	24° B.T.D.C.
Timing Letter on Rotor for Start of Injection to No. 1 Cylinder	Letter "B"
Idle Speed Adjustment:	
Low Idle Speed	575-625 RPM (PTO speed of 207-225 for tractors with 1500-540 speed transmission) (PTO speed of 182-199 for tractors with 1700-540 speed transmission)
High Idle Speed	2175 RPM (PTO speed of 783 for tractors with 1500-540 speed transmission) (PTO speed of 691 for tractors with 1700-540 speed transmission)

Fuel Injectors - MF 65 Tractor

Make and Model No.	C. A. V. multi-hole type nozzle, C. A. V. nozzle No. BDLL 150S6355, C. A. V. nozzle holder No's. BKBL 67SD5064 and BKBL 67SD5151
Nozzle Opening Pressure:	
Used Injectors (more than 25 hours operation)	2575 p. s. i.
New Injectors or Old Injectors with New Springs	2795 p. s. i.

Air Cleaner

Capacity	Fill to mark

LUBRICATION SYSTEM SPECIFICATIONS

Type of Oil

API Service Class	DG

Viscosity

Above 90° F.	SAE 30
From 32° F. to 90° F.	SAE 20 or 20/20W
From 10° F. to 32° F.	SAE 10W
From -10° F. to + 10° F.	SAE 5W or 5W/20

Crankcase Capacity

Without Filter Change	7 U. S. quarts
With Installation of New Filter	7. 5 U. S. quarts

Oil Change Period

Change Oil at Regular Intervals	Every 100 hours

Oil Pump

Capacity	6. 42 U. S. gallons per minute at engine speed of 2000 rpm
Idler Gear - Bore	0. 750 - 0. 751 inch
Idler Gear Bushing (inside diameter)	0. 6562 - 0. 6572 inch
Idler Shaft Diameter	0. 65475 - 0. 65535 inch
Idler End-Play on Hub	0. 001 - 0. 015 inch
Drive Gear - Bore	0. 4970 - 0. 4978 inch
Pump Gears Backlash	0. 012 - 0. 018 inch
Inner to Outer Rotor Clearance	0. 006 inch maximum
Outer Rotor to Pump Body Clearance	0. 010 inch maximum
Top of Rotors to Face of Pump Body Clearance	0. 003 inch maximum

Oil Pressure Relief Valve

Relief Valve Setting	50 - 65 p. s. i.
Relief Valve Spring:	
Free Length	1-1/2 inches
Lbs. Pressure @ 1-1/4 Inches	5-1/4 - 7-1/4 lbs.
Lbs. Pressure @ 1 Inch	11-1/2 - 13-1/2 lbs.

Oil Filter

Change Period	Every other oil change (200 hours)
By-Pass Valve Opens	13 - 17 p. s. i. (differential pressure)

Engine Oil Pressure

Operating Oil Pressure	25 - 60 p. s. i. at normal operating speeds

COOLING SYSTEM SPECIFICATIONS

Cooling System

Capacity	10 U. S. quarts

Thermostat

Opening Temperature	168 - 176 degrees F.

Radiator Pressure Cap

Releases Pressure At	10 p. s. i. early models, 7 p. s. i. late models

Fan Belt

Proper Tension	1/2-3/4 inch deflection

Water Pump

Impeller Blade Clearance	0. 015 - 0. 025 inch

ELECTRICAL SYSTEM SPECIFICATIONS

Battery

Make	Own
Volts	12
Ampere Hours	96
Battery Ground	Negative

Generator Regulator

Make	Delco Remy No. 1118981
Cutout Relay:	
Air Gap	0. 020 inch
Point Opening	0. 020 inch
Adjust to Close At	12. 8 volts
Allowable Closing Range	11. 8 - 14. 0 volts
Voltage Regulator:	
Air Gap	0. 075 inch
Allowable Voltage Range	13. 6 - 14. 5
Adjust to	14

Generator

Make	Delco Remy No. 1101012
Rotation Viewing Drive End	Clockwise
Circuit	A
Brush Spring Tension	24 oz. (19 oz. third brush)
Field Current (80° F.):	
Amps	2. 0 - 2. 14
Volts	12
Hot output @ approx. 2800 RPM:	
Amps	10 - 12
Volts	14. 0

Starting Motor

Make	Delco Remy No. 1107512
Minimum Brush Tension (Oz.)	35
No Load Test:	
Volts	10. 6
Minimum Amps	75 (includes solenoid)
Maximum Amps	95 (includes solenoid)
Maximum RPM	9500
Resistance Test:	
Volts	3. 5
Minimum Amps	520 (includes solenoid)
Maximum Amps	590 (includes solenoid)

PART 2— AD4.203 ENGINE OVERHAUL PROCEDURE

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This part of the manual is concerned with the AD4. 203 Diesel Engine, as used in MF 65 Tractors, starting with tractor serial number 682157.

Before starting disassembly of the tractor, make a complete diagnosis of the engine to be sure that an overhaul is really necessary. If an overhaul is necessary, inspect the entire engine for any evidence of external leaks, or defective parts, that must also be corrected before the tractor is assembled and returned to the customer.

Thoroughly steam clean the engine before disassembling it, or removing any component parts of the fuel system. Also; make sure to cap, or otherwise cover, all fuel openings as soon as they are exposed, to prevent dirt from entering the fuel

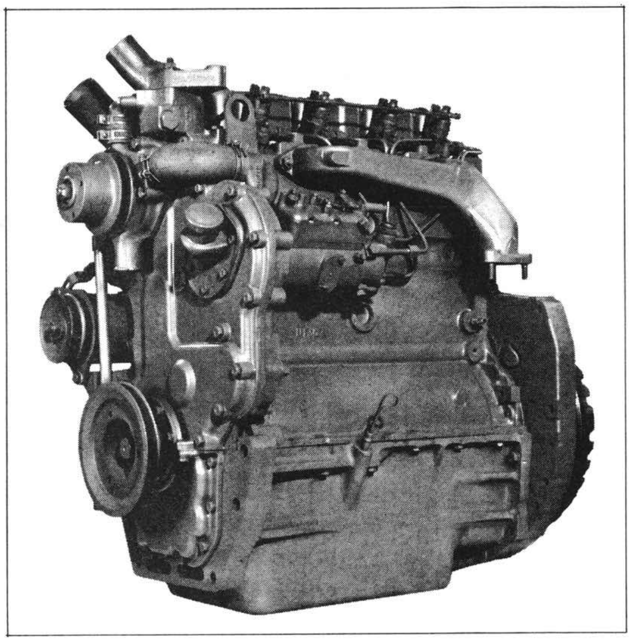

Fig. 1 – Front Left-Hand View of AD4.203 Engine

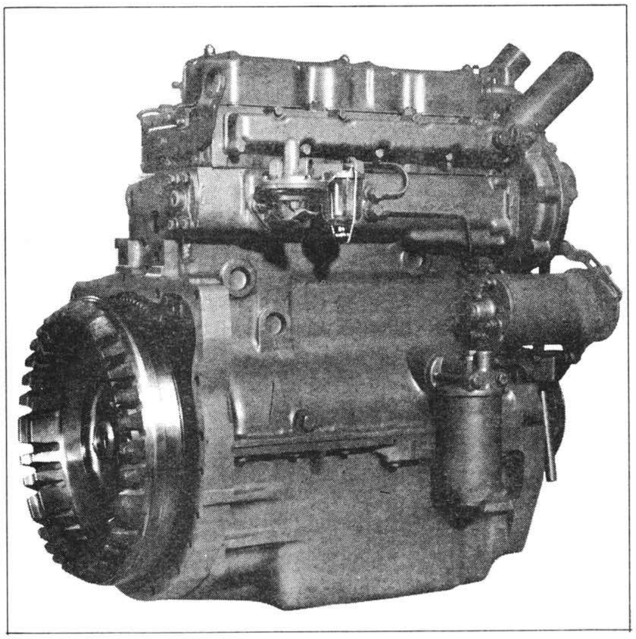

Fig. 2 – Rear Right-Hand View of AD4.203 Engine

system. CLEANLINESS IS VERY IMPORTANT AND CANNOT BE OVER-EMPHASIZED.

Where the right and left-hand sides are mentioned in this Part, it refers to the tractor or engine as viewed from the rear. Direction of engine rotation, however, is viewed from the front of the engine.

NOTE: This part of the manual is concerned only with engine overhaul. For specific detailed information concerning the lubrication system, fuel system, and the other engine systems, please refer to the appropriate part in this section of your manual.

ENGINE DESCRIPTION

The AD4. 203 Diesel Engine is a 4-cylinder, 4-stroke cycle engine, using dry-type cylinder liners with a bore of 3. 6 inches and a stroke of 5 inches. The engine has a total piston displacement of 203. 5 cu. in. and a compression ratio of 18. 5 to 1. Maximum engine torque is

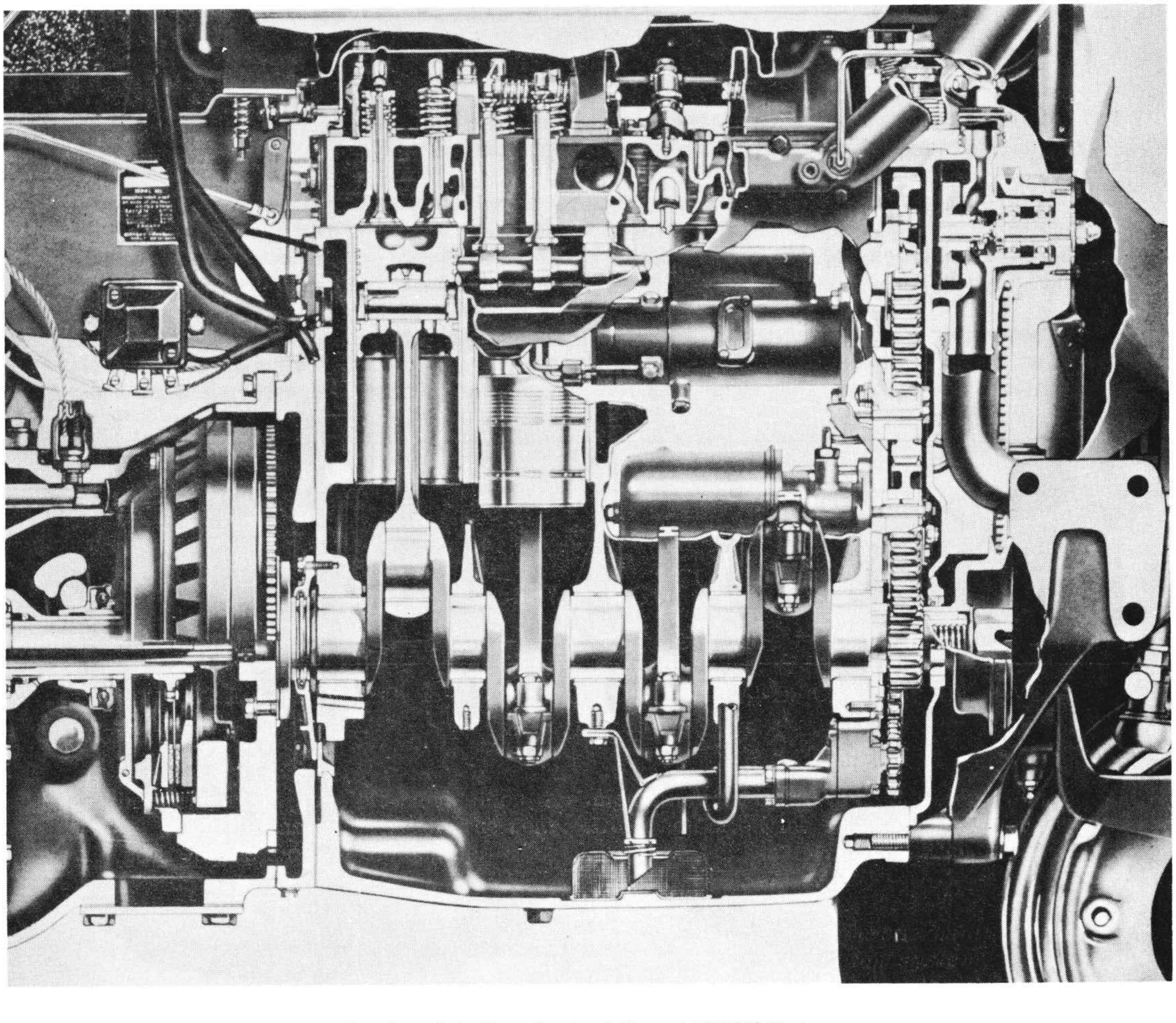

Fig. 3 – Side Cross Sectional View of AD4.203 Engine

158.5 ft.-lbs. and occurs at an engine speed of 1200 RPM.

The fuel system is of the direct injection type, employing a toroidal chamber machined in the crown of each piston. The fuel is injected into the chamber by means of a multi-hole type of injector.

The fuel injection pump is made by C. A. V. and is of the D. P. A. distributor type, with a built-in mechanical governor and an automatic advance mechanism. The pump is flange-mounted to the back of the timing gear housing and is gear-driven through two idler gears by the crankshaft gear.

The valves are vertically located in replaceable guides in the cylinder head and have two valve springs for each valve. The valves are operated by tappets from a gear-driven camshaft, which is located high on the right-hand side of the cylinder block.

Two different types of piston and cylinder liner arrangements have been used in conjunction with the AD4.203 Engine. Early engines, up to engine serial no. 2939036, used chrome-plated steel cylinder liners. Engines after serial no. 2939836, and up, have cast iron cylinder liners with different piston rings and slightly altered pistons. Both cylinder liners are of the dry-type.

The crankshaft is supported by five main bearings and is forged from chrome molybdenum steel, with induction-hardened main and crankpin journals. Crankshaft end-play is controlled by replaceable thrust washers, installed on each side of the rear main bearing.

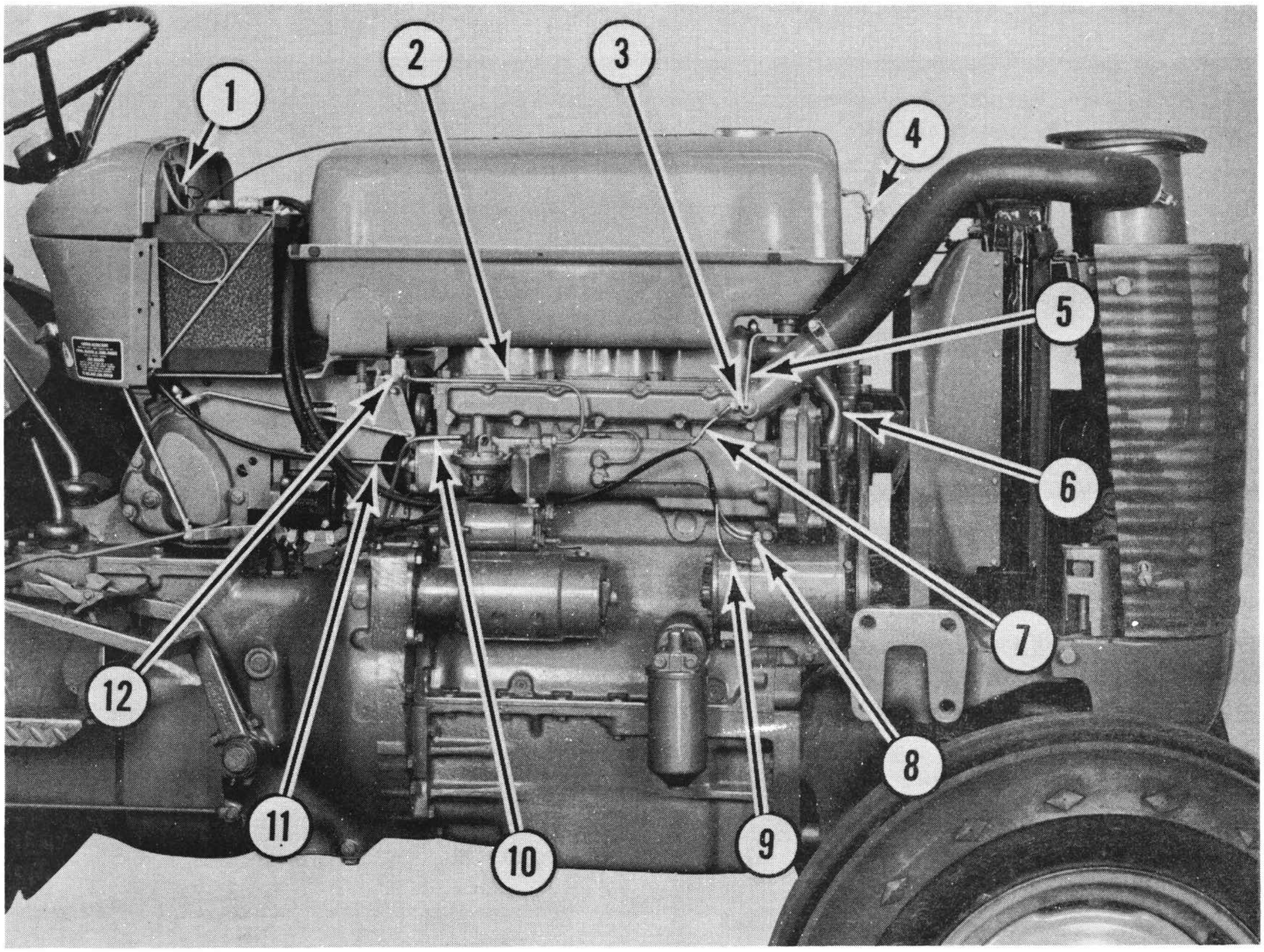

Fig. 4 – AD4.203 Engine Installation in MF 65 Tractor – Identification of Parts

1. Light Connector
2. Fuel Line – Fuel Shut-Off Valve to Fuel Lift Pump
3. Thermostart (Cold Starting Aid)
4. Leak-Off Connector Tee
5. Fuel Line – Connector Tee to Thermostart
6. Breather Pipe Hose
7. Thermostart Wire (Yellow)
8. Generator Armature Wire (Black)
9. Generator Field Wire (Striped)
10. Fuel Line – Fuel Lift Pump to Primary Fuel Filter
11. Tractormeter Drive
12. Fuel Tank Shut-Off Valve

An electric cold starting aid, known as a "thermostart", is installed in the intake manifold to assist starting under cold conditions.

ENGINE SERIAL NUMBER

The serial number for the AD4. 203 engine is stamped on a machined surface, located on the rear left-hand side of the cylinder block, near the cylinder head. The beginning serial number for the AD4. 203 engine was 2900251.

Engines having the letters "CL" stamped before the serial number have chrome-plated cylinder liners. Later engines, without the letters "CL" appearing, have cast iron cylinder liners.

As a further identification, engines with Perkins No. 41314033 oil pump have the letter "C" stamped on the machined surface. Do not confuse this letter with the letters "CL", which may also appear, indicating the type of cylinder liners.

Always specify the complete engine serial number when ordering engine parts.

ENGINE REMOVAL FROM MF 65 TRACTOR

To remove the AD4. 203 engine and clutch from the MF 65 Tractor, refer to Figs. 4, 5 and 6, and follow the steps listed:

A. PRELIMINARY OPERATIONS

1. Drain cooling system, also crankcase, if engine is to be disassembled.

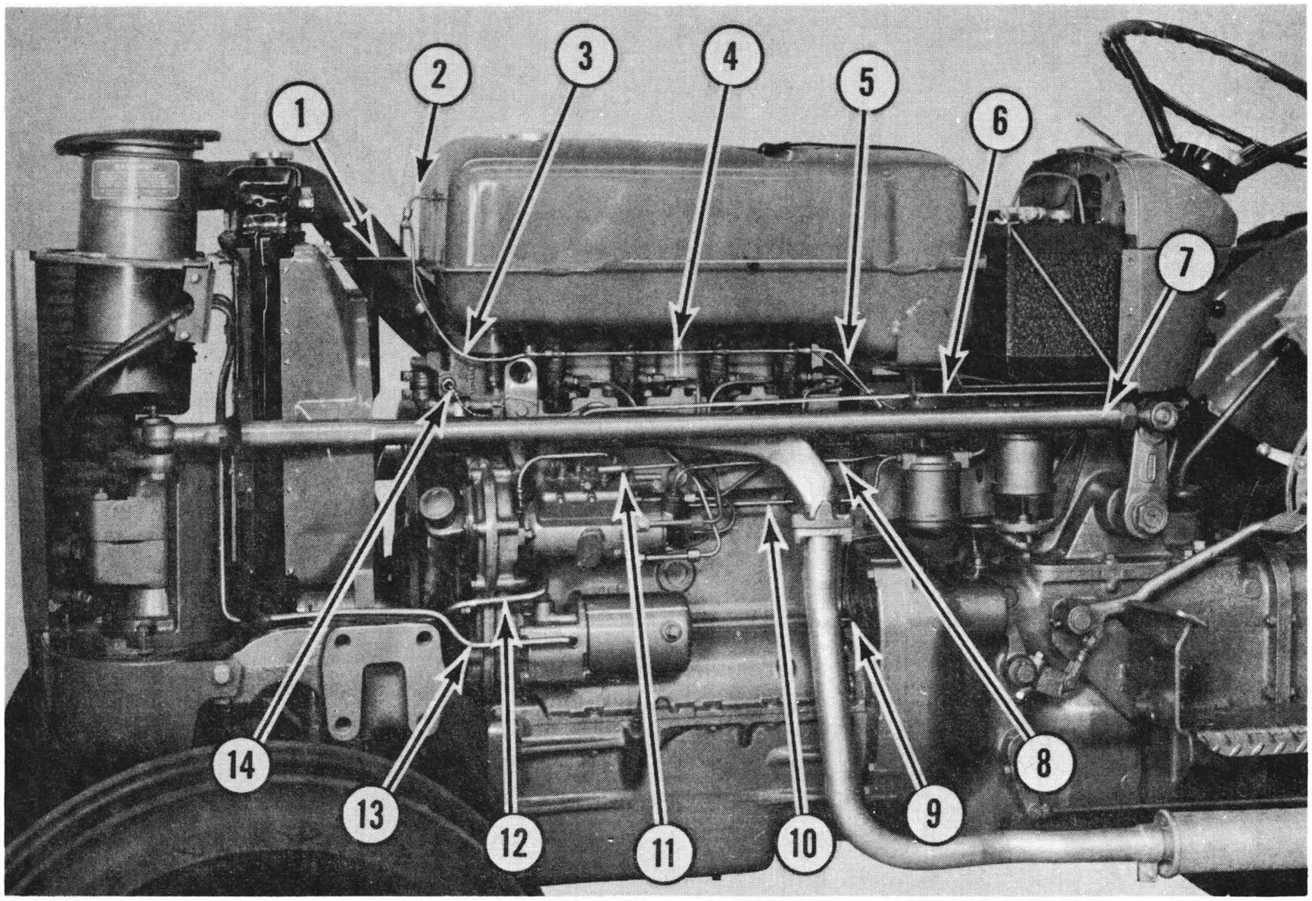

Fig. 5 – AD4.203 Engine Installation in MF 65 Tractor – Identification of Parts

1. Radiator Support Bracket
2. Fuel Line – Connector Tee to Fuel Tank
3. Fuel Line – Leak-Off Assy. to Connector Tee
4. Injector Leak-Off Line Assembly
5. Fuel Line – Secondary Filter to Leak-Off Line Assembly
6. Fuel Shut-Off Rod
7. Steering Drag Link
8. Fuel Line – Secondary Fuel Filter to Fuel Injection Pump
9. Oil Pressure Gauge Line
10. Fuel Line – Fuel Injection Pump to Secondary Fuel Filter
11. Throttle Control Rod
12. Power Steering Oil Pressure Line
13. Power Steering Oil Return Line
14. Temperature Indicator Sending Unit

2. Disconnect the headlights at the front connector, near the radiator support bracket, and at the rear connector, located on the right-hand side, near the rear of the battery.

3. Disconnect and remove the hood and side panels.

4. Disconnect and remove the battery.

NOTE: The battery is negatively grounded.

B. REMOVAL OF FUEL TANK

1. Either close the fuel shut-off valve, No. 12, Fig. 4, or drain the fuel tank, depending upon the amount of fuel present in the tank.

2. Disconnect the fuel supply line, No. 2, Fig. 4, at the fuel tank end.

3. Disconnect and remove the thermostart fuel supply line, No. 5, Fig. 4.

4. Disconnect the fuel line, No. 3, Fig. 5, at the front end of the injector leak-off line assembly, then, disconnect the fuel line, No. 2, Fig. 5, at the fuel tank and remove both fuel lines as one assembly.

5. Disconnect the fuel tank gauge wire and loosen the nuts securing the rear of the fuel tank to relieve the spring tension, then, remove the nuts securing the front of the fuel tank. Lift front of fuel tank, then, slide tank forward and remove from tractor.

C. REMOVAL OF FRONT END ASSEMBLY

1. Disconnect the upper and lower radiator hoses.

2. Disconnect the air cleaner hose at the intake manifold.

3. Disconnect the radiator support bracket, No. 1, Fig. 5, at the radiator end.

4. If equipped with power steering, disconnect the two oil lines, No's. 12 and 13, Fig. 5, at the pump end. Reposition the oil lines to prevent them from becoming damaged when the front end is separated from the engine.

NOTE: Each oil line has an "O"-ring at the pump end. Be careful not to lose or damage these "O"-rings.

5. Disconnect the rear end of the steering drag link, No. 7, Fig. 5, from the steering arm.

6. Support the tractor securely under the front of the transmission housing and under the front axle support.

7. Install wooden wedges on each side of the front axle support, between the support and the axle, to prevent the assembly from rocking sideways.

8. Loosen the three bolts on each side of the tractor securing the front axle support to the engine.

NOTE: Remove the generator and its mounting bracket as one assembly to gain access to the upper right-hand support bolt. This bolt is shorter than the two bottom axle support bolts, but is longer than the other 3 bolts. Make sure to reinstall it in its proper location.

9. With the front end and the transmission supported securely, remove the bolts securing the front end and roll the entire front end assembly away from the engine, as shown in Fig. 6.

D. SEPARATING THE ENGINE AND CLUTCH ASSEMBLY FROM THE TRANSMISSION

1. Disconnect electrical wiring from thermostart, No. 3, Fig. 4, and from starter motor, then, remove starter motor.

2. Disconnect tractormeter.

3. Disconnect fuel line, No. 10, Fig. 4, from fuel lift pump to primary fuel filter at lift pump end.

4. Disconnect fuel line No. 5, Fig. 5, from secondary fuel filter to leak-off line assembly at leak-off line end.

5. Disconnect the temperature indicator sending unit, No. 14, Fig. 5, from the thermostat housing.

6. Disconnect the fuel shut-off rod, No. 6, Fig. 5, from the fuel injection pump and slide the rod rearward.

7. Disconnect the throttle control rod, No. 11, Fig. 5, at the bellcrank end.

8. Disconnect the injection pump return fuel line, No. 10, Fig. 5, at the secondary fuel filter end.

9. Disconnect and remove the injection pump supply fuel line, No. 8, Fig. 5.

10. Disconnect the oil pressure gauge line, No. 9, Fig. 5, at the cylinder block end, then, very carefully reposition the line so that it will not become damaged when the engine is removed.

11. Disconnect the exhaust pipe from exhaust manifold.

12. Attach a chain to the engine lift brackets and support the weight of the engine, using a hoist; refer to Fig. 7.

13. Remove the two nuts securing the battery carrier to the engine adapter plate.

14. With the engine and the transmission housing securely supported, loosen all of the bolts around the outside diameter of the engine adapter plate which secure the adapter plate to the front of the transmission housing.

NOTE: Make sure to remove the bolt under the battery carrier.

15. Remove all bolts, then, very carefully separate the engine and clutch assembly from the transmission, as shown in Fig. 7.

E. REMOVING THE FLYWHEEL

1. Remove the clutch assembly, as outlined in Group 1, Section A, Part 1.

2. Release the locks securing the six setscrews and carefully remove the flywheel.

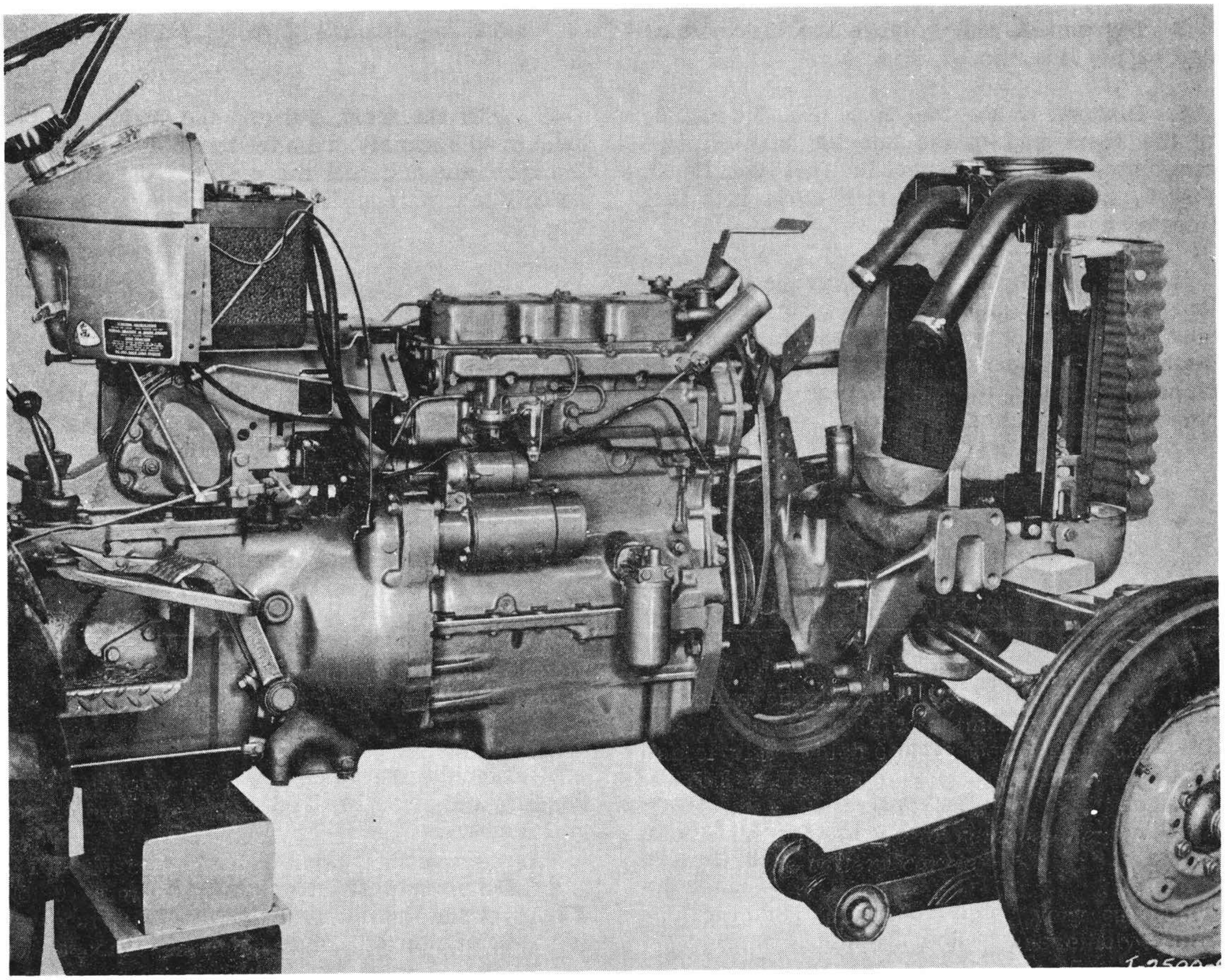

Fig. 6 – Removing Front End Assembly From MF 65 Tractor

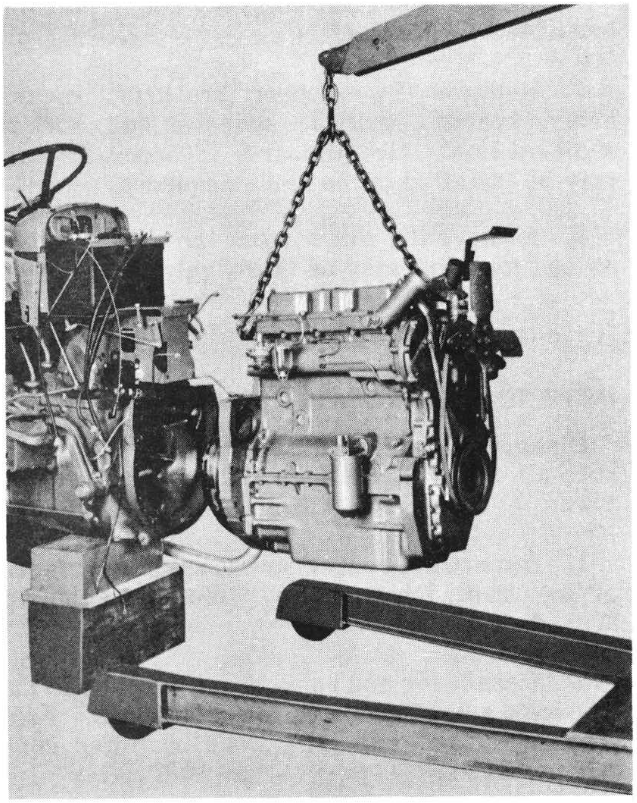

Fig. 7 – **Removing the AD4.203 Engine and Clutch Assembly from MF 65 Tractor**

NOTE: The flywheel must always be installed so that the unevenly spaced hole in the flywheel is aligned with the unevenly spaced hole in the crankshaft.

Always check flywheel run-out, after installing the flywheel, to make sure it is running true. Maximum clutch face run-out is 0.001 inch per inch of radius, from the center of the flywheel to the point of measurement. The run-out on the outer diameter of the flywheel should not exceed 0.012 inch total indicator reading.

ENGINE INSTALLATION IN MF 65 TRACTOR

To install the engine, reverse the steps listed under "Engine Removal".

NOTE: When joining the engine to the transmission housing, turn the crankshaft and/or PTO to line up the transmission shafts with the clutch plate splines. Bleed the fuel system of air, including the thermostart fuel line, as outlined in Part 3 of this section of the manual, before attempting to start the engine.

ROCKER ARM SHAFT ASSEMBLY

REMOVING THE ROCKER ARM SHAFT ASSEMBLY

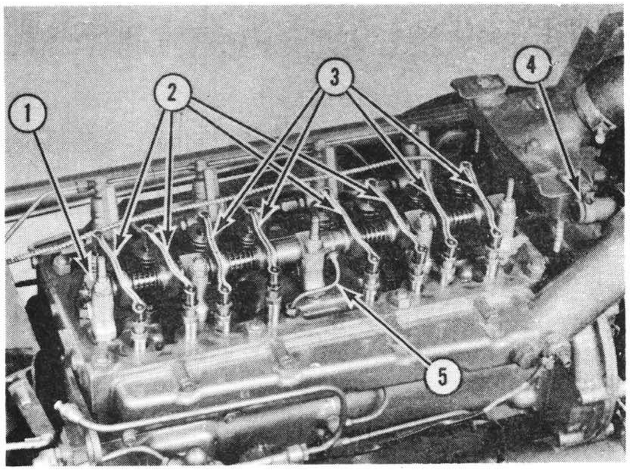

Fig. 8 – **Rocker Arm Shaft Assembly**

1. Rocker Shaft Support
2. Left-Hand Rocker Arms
3. Right-Hand Rocker Arms
4. Breather Pipe Hose
5. Rocker Shaft Oil Line

To remove the rocker arm shaft assembly, proceed, as follows: (refer to Fig. 8)

1. Disconnect hood stop lever from fuel tank and support hood in an open position.

2. Remove fuel tank, as outlined under heading "Engine Removal from MF 65 Tractor".

3. Remove nuts securing rocker arm cover and remove cover.

4. Disconnect oil line, No. 5, Fig. 8, to rocker arm shaft at cylinder head end.

5. Work from the center to both ends and gradually loosen the nuts securing the rocker shaft supports, No. 1, Fig. 8.

6. After loosening the nuts, remove them and lift rocker arm shaft assembly from cylinder head.

DISASSEMBLING THE ROCKER ASSEMBLY

Before disassembling the rocker arm shaft assembly, observe that the rocker arms are right and left-hand assemblies and cannot be

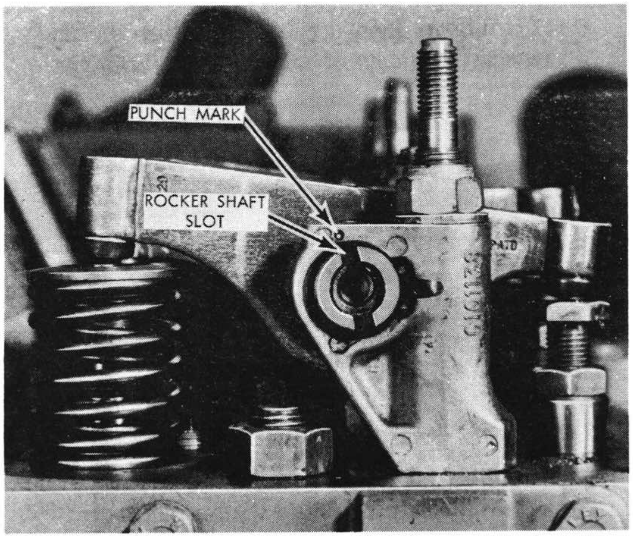

Fig. 9 – Rear Support Marked to Show Correct Positioning of Slot

interchanged; refer to No's. 2 and 3, Fig. 8. Observe that the slot in the rear-end of the rocker shaft, as shown in Fig. 9, is in line with the punch mark on the rear support bracket. The amount of oil circulating to the rocker assembly can be adjusted by positioning this slot. The punch mark on the support bracket (stamped 30 degrees from vertical position) shows where the slot is normally set.

> *NOTE: Only in the event of inadequate, or excessive rocker arm lubrication, should the slot be repositioned. Minimum oil flow occurs with the slot in the vertical position.*

To disassemble, proceed, as follows: (refer to Fig. 10)

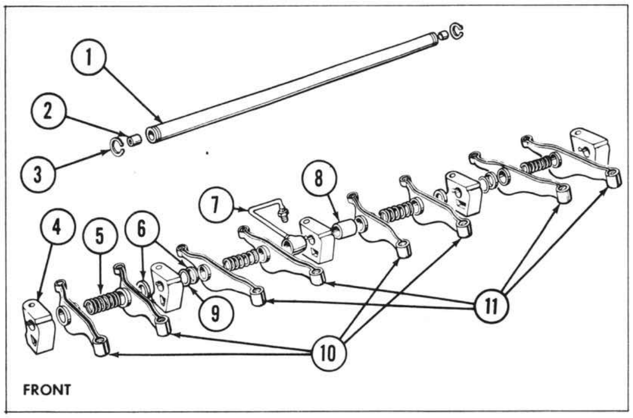

Fig. 10 – Rocker Arm Shaft Assembly – Identification and Sequence of Parts

1. Rocker Shaft
2. Rocker Shaft Plug
3. Snap Ring
4. Rocker Shaft Support Bracket
5. Rocker Shaft Spring
6. Rocker Shaft Spacers
7. Rocker Shaft Oil Line
8. Rocker Shaft Spacer
9. Rocker Shaft Shim
10. Right-Hand Rocker Arms
11. Left-Hand Rocker Arms

1. Remove the retaining snap ring from each end of the rocker shaft.

2. Remove the support brackets, rocker arms, spacer springs, spacers and rocker shaft oil line. Lay all parts in order so they may be installed in the same sequence.

3. Remove the plugs from the rocker shaft so that the shaft may be thoroughly cleaned.

INSPECTING THE ROCKER ASSEMBLY

Clean all parts in a suitable solvent; make sure all oil holes are open and proceed, as follows:

1. Inspect the rocker arm bearing surfaces of the shaft for scoring. Replace shaft, if scored.

2. Inspect for and replace any rocker arms that have seized and have loose bushings. Also discard rocker arms with worn or pitted contact surfaces.

> *NOTE: Rocker arms and bushings are not serviced separately and, if either is worn or defective, new rocker arms are available with bushings installed and reamed to proper size.*

3. Measure diameter of bearing surfaces on rocker shaft and inside diameter of rocker arm bushings. Recommended clearance between rocker arm bushings and shaft is 0.0008-0.0035 inch. Replace shaft and/or rocker arms, if clearance exceeds 0.0035 inch.

REASSEMBLING THE ROCKER ASSEMBLY

To assemble the rocker arm assembly, proceed, as follows:

1. Install all parts in their correct sequence, as shown in Fig. 10. Make sure slot in rear end of rocker shaft is matched and lined up with punch mark in rear support. Rocker arms are right and left-hand and must be positioned, as shown in Fig. 8 and 10.

2. Complete assembly by installing a new snap ring and plug at each end of the rocker shaft.

CYLINDER HEAD

REMOVING THE CYLINDER HEAD

To remove the cylinder head from the MF 65 Tractor, proceed, as follows:

1. Drain cooling system.

2. Disconnect head lights, then, remove hood and side panels.

3. Disconnect battery and remove fuel tank, as outlined under heading "Engine Removal from MF 65 Tractor".

4. Disconnect electrical wire from thermostart and air cleaner hose from intake manifold.

5. Disconnect and remove the oil line on the right-hand side of the engine connecting the cylinder block and the cylinder head. This oil line provides oil to the cylinder head for the rocker arm shaft assembly.

6. Disconnect the upper radiator hose and remove the radiator support bracket.

7. Loosen the two clamps securing the by-pass hose, then, remove the two bolts securing the by-pass connection to the thermostat housing and loosen the joint.

8. Disconnect the exhaust pipe from the exhaust manifold and remove the manifold.

> *NOTE: Be careful not to damage the fuel lines or linkage.*

9. Disconnect and remove the injector leak-off line assembly, also, the fuel line from the secondary fuel filter to the leak-off line assembly.

10. Disconnect and remove the high pressure fuel lines from the fuel injection pump to the fuel injectors.

> *IMPORTANT: Cap, or otherwise cover, all fuel line openings to prevent dirt from entering the fuel system.*

11. Disconnect the temperature indicator sending unit from the thermostat housing.

12. Disconnect the breather pipe hose from the rocker cover and remove the rocker cover.

13. Disconnect the rocker shaft oil line at the cylinder head. Work from the center to both ends and gradually loosen the nuts securing the rocker shaft supports. After loosening, remove nuts and lift rocker shaft assembly from cylinder head.

14. Loosen the cylinder head nuts in a reverse order to the tightening sequence shown in Fig. 16, then, carefully remove cylinder head.

15. If the cylinder head requires servicing, remove the fuel injectors, intake manifold, water outlet connection, thermostat and thermostat housing.

INSPECTING THE CYLINDER HEAD

Disassemble the cylinder head, then, thoroughly clean it and the other connecting parts. Make sure all sealing surfaces are clean and not damaged. Clean all scale from the water passages in the cylinder head and inspect head for cracks. Use a straightedge and determine that the cylinder head is not warped due to overheating or extreme operation.

Examine the water jacket plugs on the cylinder head and all of the cylinder block studs for looseness and damaged or stripped threads. Replace all damaged or defective parts.

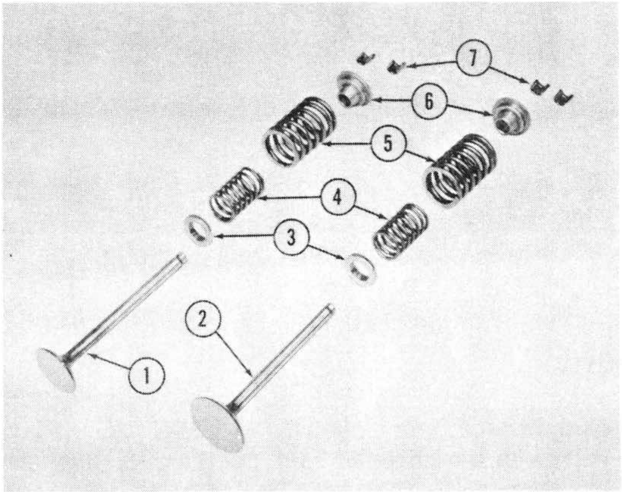

Fig. 11 – Intake and Exhaust Valve Assemblies

1. Exhaust Valve
2. Intake Valve
3. Lower Valve Spring Retainers
4. Inner Valve Spring
5. Outer Valve Spring
6. Upper Valve Spring Caps
7. Cap Retaining Locks (Keepers)

VALVES

The valves are retained in the head by caps and split-type cap retainers. Intake and exhaust valves are not interchangeable. Both valves are manufactured with 45 degree angle faces and have stem diameters of 0.311-0.312 inch. The valves, valve springs and retaining assemblies are shown in Fig. 11.

New valve specifications are, as follows:

INTAKE VALVES:

Face Angle . . . . 45 degrees
Stem Diameter . . . . 0.311-0.312 inch
Head Diameter . . . . . . 1.532-1.536 inches

EXHAUST VALVES:

Face Angle . . . . 45 degrees
Stem Diameter . . . . 0.311-0.312 inch
Head Diameter . . . . . . 1.313-1.317 inches

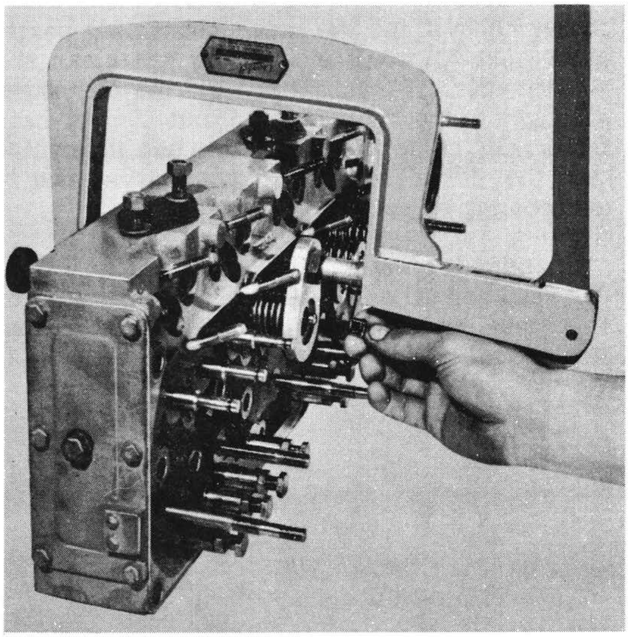

Fig. 12 – Removing or Installing the Valve Spring Cap Locks

REMOVING AND INSPECTING THE VALVES

To remove the valves, use a valve spring compressor, as shown in Fig. 12. Place valves in a numbered rack so that, if they are to be re-used, they may be installed into their original valve guides. New valves are numbered consecutively, from the front of the engine. Number replacement valves prior to installation. Thoroughly clean and inspect all valves. If valves appear to be in good condition, measure the following:

1. Thickness of valve margin - discard valves with margins less than 1/32 inch.

2. Stem Diameter - discard valves that have a stem diameter of 0.310 inch, or less.

SERVICING THE VALVES

Reface new and old serviceable valves with a 44 degree face angle (one degree interference angle used). Discard any valves that are bent or have a margin thickness of 1/32 inch, or less, after refacing.

VALVE GUIDES

Intake and exhaust valve guides are interchangeable. Inside diameter of valve guides is 0.314-0.3155 inch. The desired clearance between the guide and valve stem is 0.002-0.0045 inch for both intake and exhaust. Replacement valve guides are pre-sized and do not require reaming.

INSPECTING THE VALVE GUIDES

Thoroughly clean and examine guides. Replace guides that are scored, or otherwise damaged. Measure the inside diameter of the valve guides and replace guides, if diameter is more than 0.3155 inch, or if valve guide-to-stem clearance exceeds 0.0045 inch.

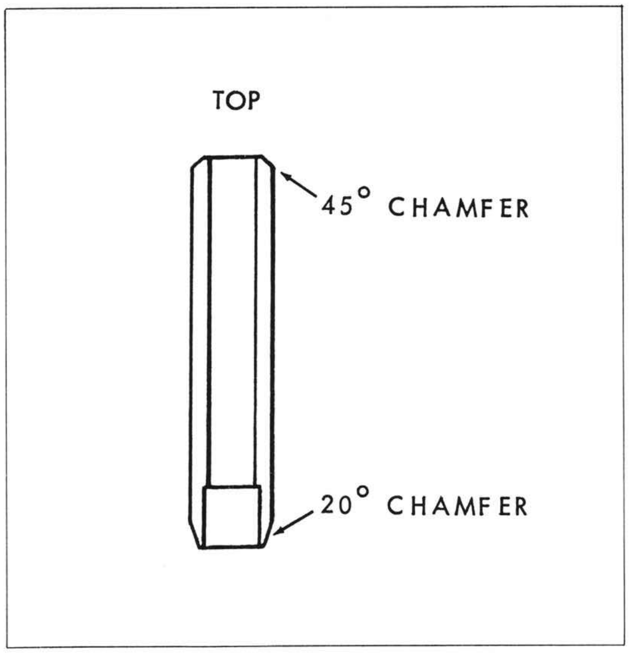

Fig. 13 – Shoulderless Type Valve Guide

REPLACING THE VALVE GUIDES

Worn valve guides may be removed by pressing them out the TOP of the cylinder head. To install new valve guides, use a piloted drift, 0.002 inch smaller than the inside diameter of the guides, and **PRESS** (do not drive) them into position from the **TOP** of the cylinder head.

When installing the shoulderless guides, insert the 20 degree chamferred end, as shown in Fig. 13 (both ends are chamferred, but with different angles), from the **TOP** of the cylinder head. Press the valve guide into the head until the top end (45 degree chamferred end) extends 0.584-0.594 inch above the **TOP** face of the head.

VALVE SEATS

Both the intake and exhaust valves seat directly in the cylinder head, with no seat inserts being used.

INSPECTING THE VALVE SEATS

Thoroughly inspect each valve seat for pitting, burning or other evidence of leakage. If any of these conditions exist, or if new valve guides have been installed, the valve seats must be refaced.

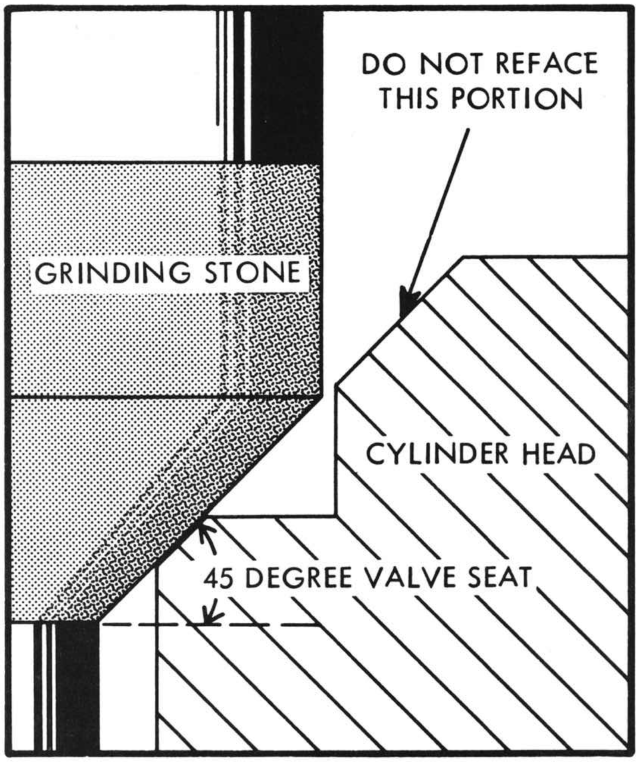

Fig. 14 – Refacing the Valve Seats

SERVICING THE VALVE SEATS

Reface intake and exhaust valve seats to a 45 degree angle (one degree interference angle used). Remove **ONLY** enough metal to clean up and true the face; refer to Fig. 14.

> *IMPORTANT: The head of the intake and exhaust valves, when installed in the cylinder head, must be between 0.066-0.140 inch below the cylinder head face. NO NOT reface the valve seat or valve to the point that the valve depth exceeds the amount specified.*

After refacing the valve seats, install the valves and check with prussian blue for width and location of contact area. Contact area should be in the middle of the valve face and not exceed 3/32 inch width.

VALVE SPRINGS

The valve springs, caps and split-type retainers are interchangeable for the intake and exhaust valves. Two valve springs are used for each valve. Neither one of the springs have damper coils and may be installed with either end up.

INSPECTING THE VALVE SPRINGS

Discard any valve springs that do not have square ends, also, those that are discolored, damaged or otherwise defective. If springs appear to be in good condition, check in a spring tester and compare readings with the following specifications:

OUTER SPRING:

Approximate Free Length	1-25/32 inches
Spring Length Valve Closed	1-1/2 inches
Spring Pressure at 1-1/2 Inch Length	21-25 lbs.
Spring Length Valve Open	1-5/32 inches
Spring Pressure at 1-5/32 Inch Length	48-52 lbs.

INNER SPRING:

Approximate Free Length	1-3/8 inches
Spring Length Valve Closed	1-3/16 inches
Spring Pressure at 1-3/16 Inches	7-9 lbs.
Spring Length Valve Open	27/32 inch
Spring Pressure at 27/32 Inch	21-25 lbs.

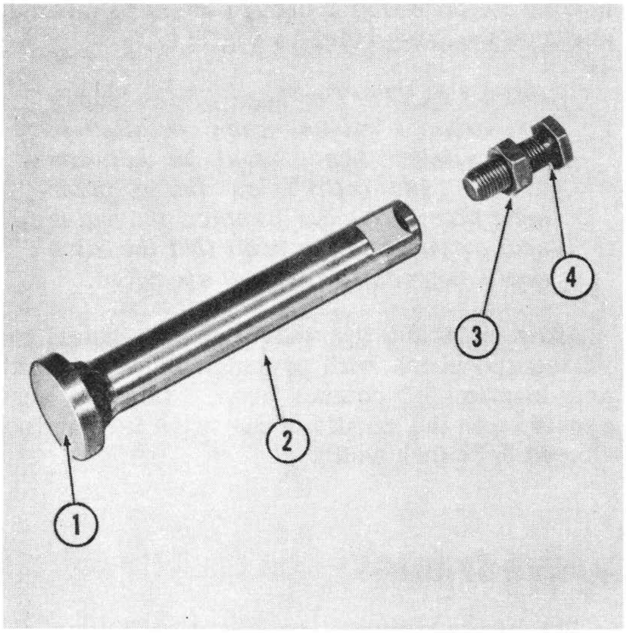

Fig. 15 – Tappet with Adjusting Screw and Locknut

1. Tappet Face 2. Tappet 3. Lock Nut 4. Adjusting Screw

TAPPETS

The tappets are of the mushroom-type and operate directly in the cylinder head. Fig. 15 shows a tappet removed from the cylinder head.

REMOVING THE TAPPETS

To remove the tappets, proceed, as follows:

1. Remove the cylinder head.

2. Remove tappet adjusting screw and locknut.

3. Remove tappets and number them so that they may be installed into their original bores.

INSPECTING THE TAPPETS

Thoroughly clean the tappets and inspect them, as follows:

1. Make sure tappets are free to rotate and that they will slide into their bores under their own weight.

2. Inspect the tappet face. If the face of the tappet is worn or damaged, the tappet must be replaced.

NOTE: Do not re-grind the face of the tappet.

3. Measure the tappet bore and the tappet stem diameter. Clearance between bore and

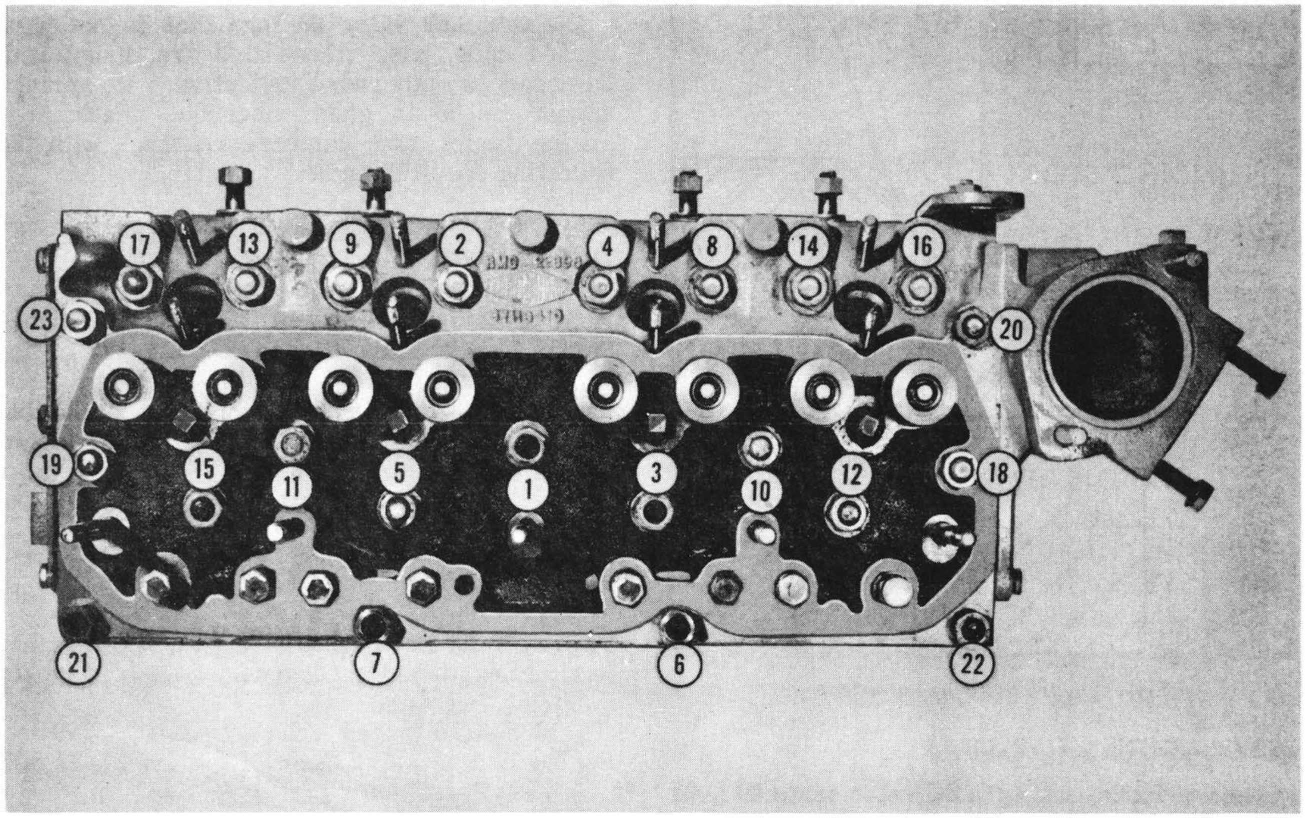

Fig. 16 – Cylinder Head Tightening Sequence

stem should be between 0.00075-0.0035 inch. Install new tappets, if clearance exceeds 0.0035 inch.

REASSEMBLING THE CYLINDER HEAD

Make sure all parts are thoroughly clean and serviceable, and proceed, as follows:

1. Lubricate the valve stems and guides with engine oil.

2. Using a valve spring compressor, install the valves into their proper guides. Refer to Fig. 11 for proper sequence of parts.

3. Replace the thermostat body, thermostat and outlet connection, if they have been removed. Use new gaskets and a suitable sealing compound.

4. Use a new gasket and install the intake manifold. Make sure to use the plain aluminum washers with the bolts to prevent unfiltered air from leaking into the manifold.

INSTALLING THE CYLINDER HEAD

1. Make sure the mating surfaces of the cylinder block and head are clean, then, lightly coat both sides of the cylinder head gasket with an aviation-grade sealing compound (non-hardening).

2. Note that the head gasket is marked "Top Front" and install it onto the block in this position.

> *NOTE: If a cylinder head gasket failure has occurred, make sure to use the latest gasket, Perkins Part No. 36812126, and refer to the heading "Inspecting the Cylinder Block" in this part for additional information concerning head gasket failures.*

3. Install the cylinder head and tighten the cylinder head nuts in the sequence shown in Fig. 16 to 55-60 ft.-lbs. torque.

4. Install the rocker arm assembly and connect oil line between rocker shaft and cylinder head. Make sure the slot in the rocker shaft is to the rear of the engine and that it is in line with the punch mark on the rear support.

5. Set tappet clearance to 0.012 inch "cold".

6. Connect oil line between cylinder head and cylinder block.

7. Install injectors, USING NEW WASHERS, and tighten nuts evenly to 20-22 ft.-lbs. torque. Make sure to install only one washer with each injector.

> *NOTE: Make sure each injector fits freely into its bore and that it is tightened down evenly. If either of these conditions exist, the nozzle can foul with consequent distortion and sticking of the valve, resulting in loss of power and a dirty exhaust.*

8. Install the rocker cover, using a new gasket. Complete reassembly by reversing the steps listed under the heading 'Removing the Cylinder Head". Make sure to use new gaskets when assembling the engine and DO NOT BEND FUEL LINES.

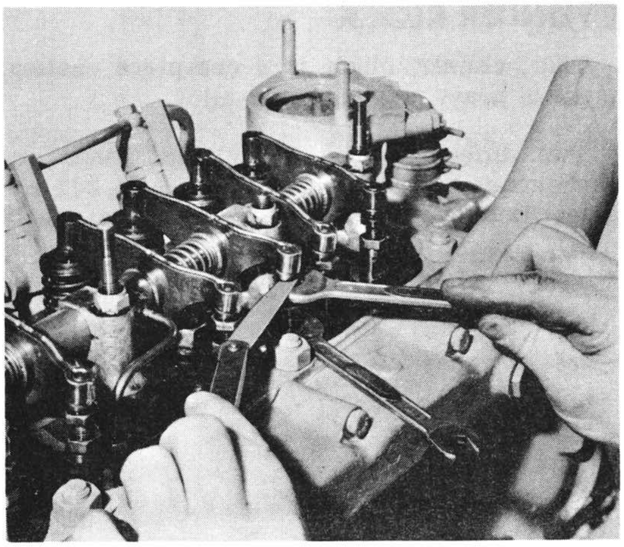

Fig. 17 – Adjusting the Valve Tappet Clearance

ADJUSTING VALVE TAPPET CLEARANCE

Both the intake and exhaust valve clearances should be set at 0.010 inch "hot", or at 0.012 inch "cold". The engine firing order is 1-3-4-2. To adjust the clearance "cold", refer to Fig. 17, and proceed, as follows:

1. Remove fuel tank and rocker cover.

2. Remove the plug from the inspection hole in the front left-hand side of the transmission housing adapter plate.

3. Turn the engine until the T. D. C. mark on the flywheel is positioned in the middle of the

inspection hole and the rocker arms of No. 4 cylinder start to rock; this indicates No. 1 piston is at T.D.C. compression stroke, with both valves closed.

4. Adjust the valve clearance of both valves on No. 1 cylinder.

5. Turn the engine to the next compression stroke and, with No. 2 cylinder rocker arms starting to rock, adjust the tappets of No. 3 cylinder.

6. With No. 1 cylinder rocker arms starting to rock, adjust the tappets of No. 4 cylinder.

7. With No. 3 cylinder rocker arms starting to rock, adjust the tappets of No. 2 cylinder, as shown in Fig. 17.

CYLINDER BLOCK

The cylinder block is a one-piece casting, made of heavy duty cast iron alloy.

Two different types of cylinder liner arrangements have been used in the AD4.203 engine. Both cylinder liner arrangements are of the dry-type but cannot be interchanged with one another. Cylinder blocks, prior to engine serial no. 2939036, require chrome-plated cylinder liners and can be easily identified by the letters "CL" stamped before the engine serial number.

Cylinder blocks starting with serial no. 2939036 have cast iron cylinder liners.

WHEN REPLACING CYLINDER LINERS, MAKE SURE TO INSTALL THE TYPE OF LINER FOR WHICH THE CYLINDER BLOCK WAS MACHINED.

The main bearing bores in the cylinder block and the main bearing caps are machined with the caps in place. For this reason, the bearing caps are not replaceable and cannot be interchanged between cylinder blocks, or located in different positions. For identification purposes, the main bearing caps are numbered from the front of the engine, as shown in Fig. 18, and both the cylinder block and main bearing caps are marked with an identification number. The caps must always be installed in their original location with their identification number toward the identification number on the block, as shown in Fig. 18.

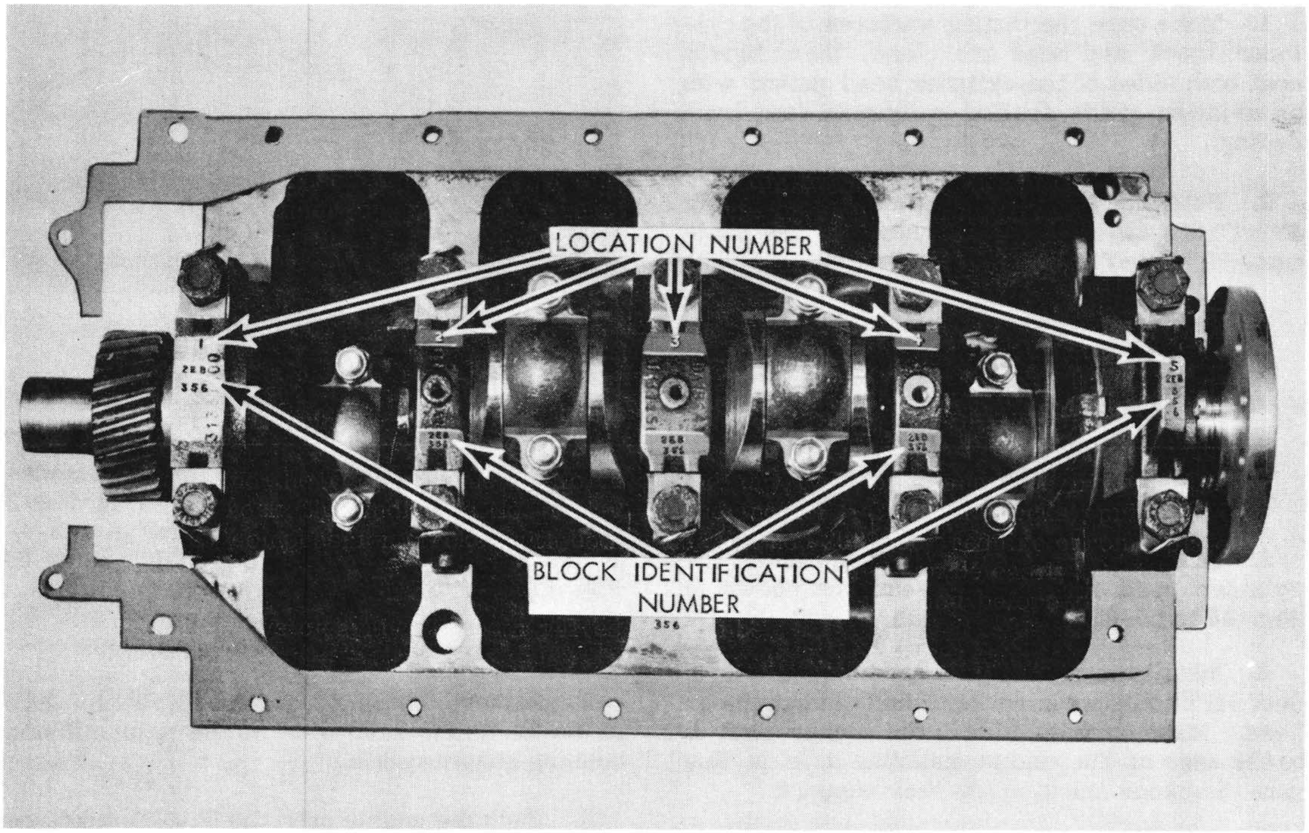

Fig. 18 – Cylinder Block and Main Bearing Caps are Marked for Proper Identification

INSPECTING THE CYLINDER BLOCK

After the cylinder block has been stripped of all removable parts, the entire casting, including the oil and coolant passages, should be thoroughly cleaned and the block inspected, as follows:

1. Inspect for and replace expansion plugs showing signs of leakage.

2. Inspect the cylinder head studs to make sure they are not stripped or otherwise damaged.

3. Inspect for "popping" of thread material from the block around the studs which may be caused by over-torquing the cylinder head nuts.

> *NOTE: This "popping" condition, caused by over-tightening in the cylinder head nuts, can result in repeated cylinder gasket failures and distortion to the cylinder liner bore near the studs, thus, causing possible piston seizure.*

Cylinder blocks, starting with serial number 2939036, have counterbored holes for the cylinder head studs and require longer studs than used earlier, to assist in preventing this "popping" condition.

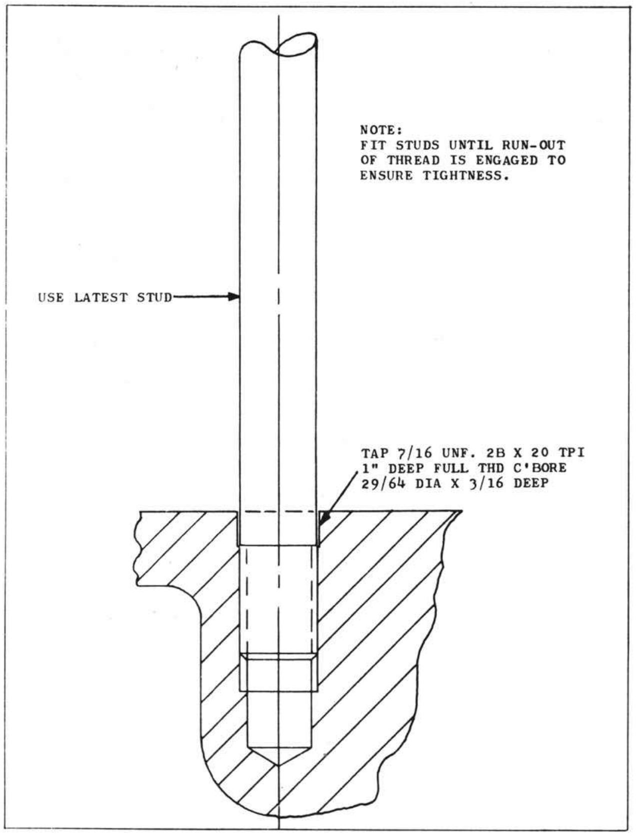
NOTE:
FIT STUDS UNTIL RUN-OUT OF THREAD IS ENGAGED TO ENSURE TIGHTNESS.
USE LATEST STUD
TAP 7/16 UNF. 2B X 20 TPI
1" DEEP FULL THD C'BORE
29/64 DIA X 3/16 DEEP

Fig. 19 – Modifying Early Cylinder Blocks for Longer Type Studs (Engines Prior to Serial No. 2939036)

If inspection reveals that thread "popping" has occurred in cylinder blocks, prior to serial no. 2939036, the cylinder block surface should be trued and, then, the block stud holes modified and the longer studs installed, as follows:

a. Refer to Fig. 19 and counterbore the stud hole 29/64 inch diameter x 3/16 inch deep.

b. Increase the threaded section of the stud hole to 1 inch full thread, using 7/16 UNF-2B x 20 bottoming tap. Lubricate during tapping and clean out stud holes afterward.

c. Install longer studs until runout of threads is engaged to ensure tightness.

4. Use a straightedge and feeler gauge and inspect the top face of the cylinder block for possible warpage due to extreme overheating or other abnormal operation. The face of the cylinder block should be true within 0.003 inch. If the cylinder block is not true and exceeds the amount specified, it may be refaced lightly, providing the piston height (when measured at T. D. C.) is within the limits of 0.0015 to 0.008 inch above the face of the cylinder block, after the refacing operation.

5. Use a dial indicator and check the parent cylinder bores in the cylinder block. Measure the inside diameter in two directions (at right angles) at the top, center and bottom of each bore. MAKE SURE THE BORES ARE THOROUGHLY CLEAN WHEN PERFORMING THIS CHECK. The cylinder block bores must not be out-of-round more than 0.001 inch.

If the bores are distorted, due to overheating or other abnormal conditions, they should be trued up by very lightly honing them to an inside diameter of 3.6875-3.6885 inches.

Under no circumstances should the bores be honed to the extent that a new cylinder liner, which has been carefully cleaned and lubricated, will slide fully home under its own weight. Refer to heading "Installing Cylinder Liners" for additional information.

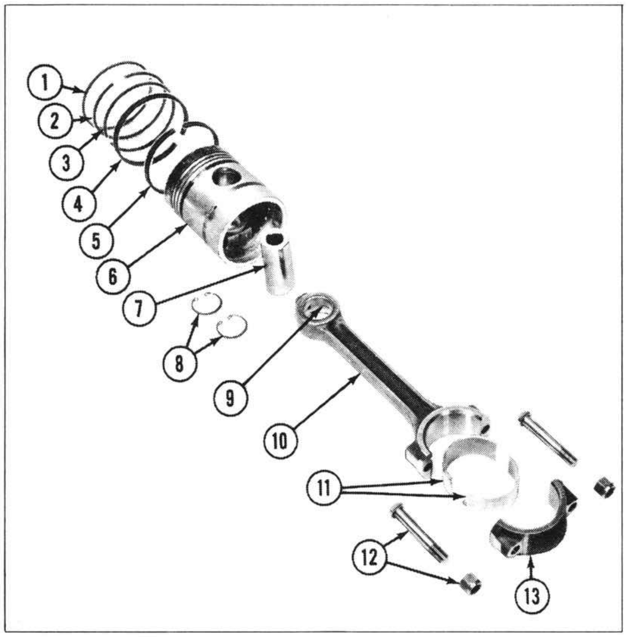

Fig. 20 – Piston and Connecting Rod Assembly – Identification and Sequence of Parts

1. Top Compression Ring
2. No. 2 Compression Ring
3. No. 3 Compression Ring
4. No. 4 Ring (Oil Control)
5. No. 5 Ring (Oil Control)
6. Piston
7. Piston Pin
8. Piston Pin Retainers
9. Connecting Rod Bushing
10. Connecting Rod
11. Connecting Rod Bearing Inserts
12. Connecting Rod Bolt and Self Locking Nut
13. Connecting Rod Cap

PISTON AND CONNECTING ROD ASSEMBLY

Fig. 20 shows the parts of the piston and connecting rod assembly. The pistons are cam-ground, and are made of a special light aluminum alloy.

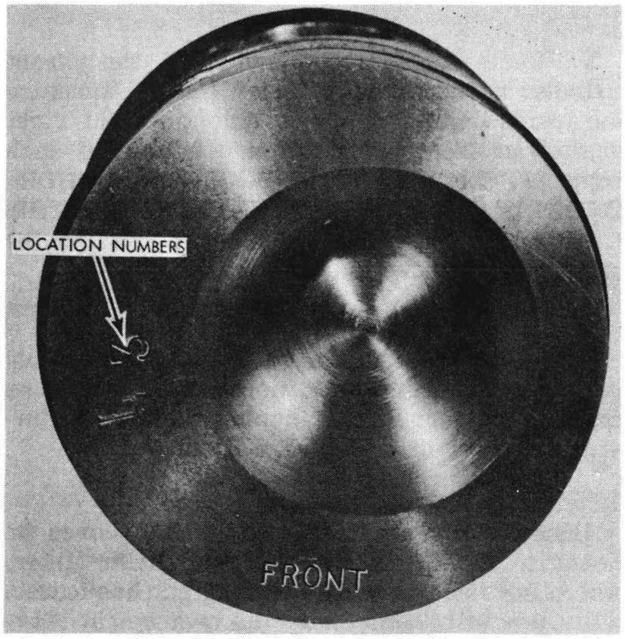

Fig. 21 – Pistons Marked with Word "Front" to Indicate Correct Positioning

All pistons are marked with the word "Front", as shown in Fig. 21, to indicate the correct positioning of the piston inside the cylinder.

Five piston rings are installed to each piston; three compression rings and one oil ring above the piston pin and one oil ring below the pin.

Two different types of piston and ring arrangements have been used in production of the AD4. 203 engine, depending upon the type of cylinder liner used. Early engines, prior to engine serial no. 2939036, have chrome-plated cylinder liners and require a piston ring arrangement, which does not contain any chrome-type piston rings. Engines, serial no. 2939036, and up, have cast iron cylinder liners and require a slightly altered piston with a different ring arrangement involving the use of chrome-type piston rings.

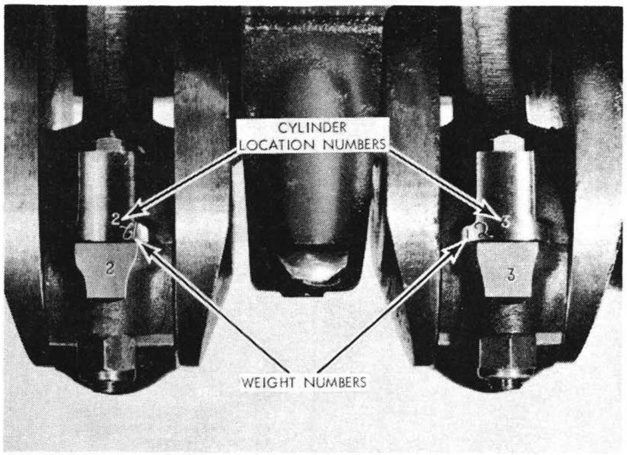

Fig. 22 – Connecting Rods are Numbered and Graded by Weight

The connecting rods are fitted with replaceable piston pin bushings. The crank end of the rods are fitted with interchangeable, precision-type bearing inserts. Replaceable connecting rod bearing inserts are available in standard size and 0. 010 inch, 0. 020 inch and 0. 030 inch undersize. The connecting rods and bearing caps are numbered from the front of the engine, as shown in Fig. 22, with the numbers opposite the camshaft side of the engine. Connecting rods are graded by weight and are also numbered, as shown in Fig. 22, to indicate their respective weights, as follows:

Numbers	Rod Weight (includes bearing cap, piston pin bushing, also nuts and bolts.)
No. 9	. . . 3 lbs., 0 ozs. - 3 lbs., 2 ozs.
No. 10	. . . 3 lbs., 2 ozs. - 3 lbs., 4 ozs.

Numbers	Rod Weight (includes bearing cap, piston pin bushing, also nuts and bolts.)
No. 11 . . .	3 lbs., 4 ozs. - 3 lbs., 6 ozs.
No. 12 . . .	3 lbs., 6 ozs. - 3 lbs., 8 ozs.
No. 13 . . .	3 lbs., 8 ozs. - 3 lbs., 10 ozs.
No. 14 . . .	3 lbs., 10 ozs. - 3 lbs., 12 ozs.
No. 15 . . .	3 lbs., 12 ozs. - 3 lbs., 14 ozs.

The full floating-type piston pins are retained by snap rings and are available in standard size, only.

REMOVING THE PISTON AND CONNECTING ROD ASSEMBLIES

Whenever it is necessary to service the piston and connecting rod assemblies, they should be removed, as follows:

1. Drain oil, also coolant, from radiator and cylinder block.

2. Remove hood and side panels, fuel tank, rocker arm cover, rocker assembly and cylinder head, as outlined earlier.

3. Remove the oil pan. For detailed procedure concerning removal of oil pan, refer to part 4 in this section.

4. Turn the crankshaft until the piston to be removed is at the bottom of its stroke.

5. If necessary, remove the oil pump suction and delivery pipes.

6. Carefully remove any carbon that may have formed at the top of the cylinder liner bore.

7. Very carefully feel the upper piston ring travel area to determine if there is any cylinder ridge present inside the cylinder liner, then, proceed, as follows:

a. ENGINES, PRIOR TO SERIAL NO. 2939036, WITH CHROME-PLATED CYLINDER LINERS - IF ANY CYLINDER ridge is present in the chrome-plated cylinders liners, make sure to install new liners, before reassembling the engine.

DO NOT ATTEMPT TO RIDGE-REAM, OR HONE THE OLD CYLINDER LINERS AND ATTEMPT TO RE-USE THEM. Refer to heading "Cylinder Liner Inspection" for additional information

b. ENGINES, 2939036, AND UP, WITH CAST IRON CYLINDERS LINERS - If there is a cylinder ridge present in the cast iron cylinder liner, then, determine if the cylinder liner is to be re-used and remove the ridge to allow removal of the piston and connecting rod assembly.

8. Remove the self-locking nuts from the connecting rod bolts and remove the bearing cap and the connecting rod bolts.

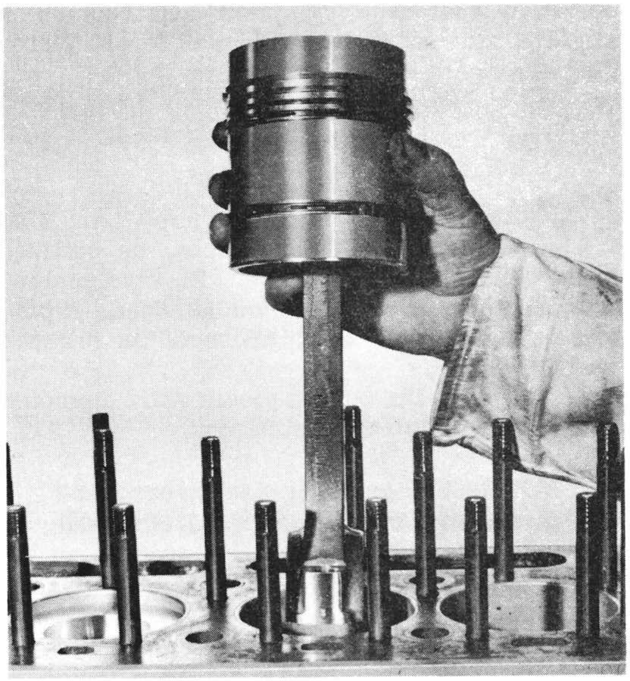

Fig. 23 – Removing or Installing the Piston and Connecting Rod Assembly

9. Remove piston and connecting rod assembly from top of block, as shown in Fig. 23.

NOTE: Identify and lay out all parts in their order of removal so that, if serviceable, they may be reinstalled in their original cylinders.

10. Discard the old piston rings and clean the entire piston and connecting rod assembly.

REMOVING PISTON FROM CONNECTING ROD

To separate the piston from the connecting rod, first, remove the snap ring from each end of the piston pin. Heat piston in oil or water to 140-160 degrees F., and slip piston pin out of the piston.

PISTONS AND RINGS

Two different types of piston and ring arrangements have been used in production of the AD4. 203 engine.

Engines, prior to engine serial no. 2939036, have steel, chrome-plated cylinder liners and require a particular piston ring arrangement in conjunction with the chrome-plated liners.

Engines with serial numbers 2939036, and up, have cast iron cylinders and require a slightly altered piston with a different piston ring arrangement.

Pistons

Thoroughly inspect the pistons, as outlined in the general engine section. Discard pistons that are scored, or otherwise damaged. If pistons appear serviceable, proceed, as follows:

1. Measure the bottom piston skirt diameter at a right angle to the piston pin.

> *NOTE: The piston is cam-ground and is slightly tapered (0.003-0.004 inch) being larger at the bottom than at the top. New bottom piston skirt diameter is 3.5955-3.5965 inches. Discard pistons that are collapsed or worn.*

2. Inspect for worn ring grooves. Piston ring groove clearance specifications are, as follows:

No. 1 Compression Ring	0.0019-0.0039 inch
No. 2 Compression Ring	0.0019-0.0039 inch
No. 3 Compression Ring	Not applicable
No. 4 Oil Ring:	
Prior to Serial No. 2939036	0.002-0.004 inch
Engines 2939036, and Up	Not applicable
No. 5 Oil Ring	0.002-0.004 inch

Discard pistons that have worn ring grooves or bent lands.

3. Inspect the piston pin bores for wear. Discard pistons with bores that measure more than 1.250 inches or those that, when fitted with a new piston pin, require less than a light hand push fit, using oil. Correct clearance between piston pin and piston pin bore is from minus 0.00025 inch to plus 0.00025 inch.

Piston Rings

NEVER INSTALL USED RINGS ONTO A NEW OR USED PISTON. Before installing the piston rings, check the ring end gaps in the lower unworn portion of the cylinder liner. Proper ring end gap in a new liner is 0.009-0.013 inch, for all of the one-piece piston rings.

When installing the piston rings, use a piston ring tool for all of the one-piece rings. Install the lowest groove ring, first, then, the next lowest, etc., with the top groove ring installed last. Description of the piston rings and their correct placement is, as follows:

Description and Placement of Piston Rings
Used with Chrome-Plated Cylinder Liners

No. 1 Compression Ring	Parallel-faced cast iron ring, and may be installed either side up.
No. 2 Compression Ring	Taper-faced cast iron ring, and MUST be installed in second groove, with side marked "Top" toward top of piston.
No. 3 Compression Ring	Three-piece, segmented-type, and each piece must be carefully spiraled onto the piston by hand, as follows:

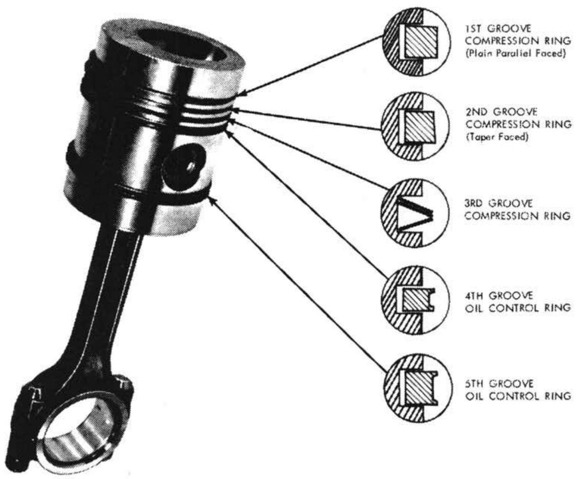
1ST GROOVE COMPRESSION RING (Plain Parallel Faced)
2ND GROOVE COMPRESSION RING (Taper Faced)
3RD GROOVE COMPRESSION RING
4TH GROOVE OIL CONTROL RING
5TH GROOVE OIL CONTROL RING

Fig. 24 – Piston Ring Arrangement Used with Chrome Plated Liners

1. Place one of the segments (all 3 are identical) horizontally in the palm of the hand and radially compress it. Notice that, when the ring is compressed, the ring ends either point up or down, depending upon which side of the segment is turned up.

2. Fit the first segment onto the piston so that, when held and radially compressed, the ring ends point downward. Position this ring at the bottom of the groove with the gap over the piston pin bore.

3. Fit the second segment on top of the first so that, when held and compressed, as described above, the ring ends point upward. Position the gap at 180 degrees to the first segment gap.

4. Fit the third segment on top of the second so that, when held and compressed, as described, the ring ends point upward. Position the gap directly over that of the first segment. Fig. 24 shows the segments correctly installed.

No. 4 Oil Control Ring (above piston pin). . . . . . Cast iron scraper and may be installed either side up.

No. 5 Oil Control Ring (below piston pin). . . . . . Cast iron scraper and may be installed either side up.

Description and Placement of Piston Rings Used with Cast Iron Cylinder Liners

No. 1 Compression Ring. . . . . Chrome-plated, parallel-faced cast iron ring, and may be installed either side up.

No. 2 Compression Ring . . . . Parallel-faced cast iron ring and may be installed either side up.

No. 3 Compression Ring . . . . Four-piece, segmented-type, and each piece must be carefully spiraled onto the piston by hand, as follows:

1. Place one of the segments (all 4 are identical) horizontally in the palm of the hand and radially compress it. Notice that when the ring is compressed, the ring ends either point up or down, depending upon which side of the segment is turned up.

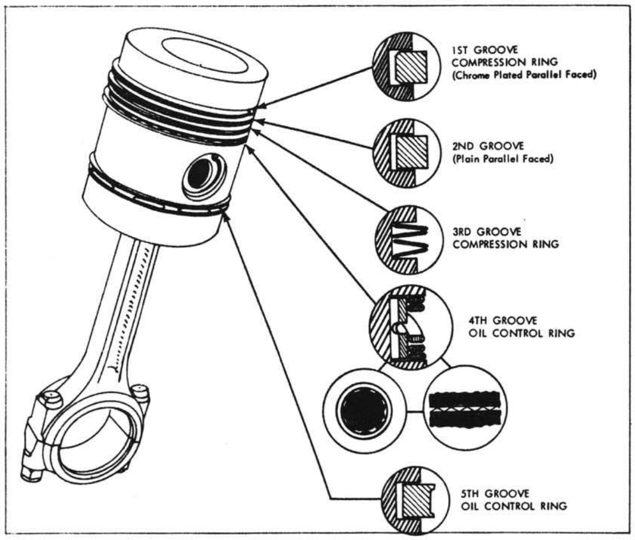
1ST GROOVE COMPRESSION RING (Chrome Plated Parallel Faced)
2ND GROOVE (Plain Parallel Faced)
3RD GROOVE COMPRESSION RING
4TH GROOVE OIL CONTROL RING
5TH GROOVE OIL CONTROL RING

Fig. 25 – Piston Ring Arrangement Used with Cast Iron Liners

2. Fit the first segment onto the piston so that, when held and radially compressed, the ring ends point downward. Position this ring at the bottom of the groove, with the gap over the piston pin bore.

3. Fit the second segment on top of the first so that, when held and compressed, as described above, the ring ends point upward. Position the gap at 180 degrees to the first segment gap.

4. Fit the third segment on top of the second so that, when held and compressed, as described, the ring ends point downward. Position this ring with the gap over the piston pin bore and at 180 degrees to the second ring gap.

5. Fit the fourth segment on top of the third so that, when held and compressed, as described, the ring ends point upward. Position the gap directly over that of the second segment. Fig. 25 shows the segment correctly installed.

No. 4 Oil Control Ring (above piston pin) . . . . . Chrome - plated duaflex laminated ring, and should be installed, as follows:

1. Install the internal expander in the ring groove.

2. Spiral two of the chrome-plated rails onto the piston (one at a time), and locate them at the bottom of the groove.

3. Install the center spring on top of the two rails.

4. Spiral the other two rails onto the piston (one at a time), and locate them in the top of the groove.

5. Turn the rails so that the gaps are staggered around the piston.

No. 5 Oil Control Ring (below piston pin) . . . . . Cast iron scraper, and may be installed either side up.

CONNECTING RODS

Check connecting rods for proper alignment. Discard or straighten any rods that are misaligned.

> *NOTE: REPLACE ALL UNSERVICEABLE RODS WITH NEW ONES OF THE SAME WEIGHT. Replacement rods are not numbered as to the correct cylinder location and should be marked prior to installation.*

Install a new piston pin bushing, if inside bushing diameter exceeds 1.2515 inches.

Connecting rod bearing inserts are available in standard size or in 0.010 inch, 0.020 inch and 0.030 inch undersize.

New specifications are, as follows:

Crankpin Diameter	2.2485-2.249 inches
Recommended Bearing Clearance	0.0025-0.004 inch
Rod Side-Play	0.0095-0.0133 inch

Replacing the Bushings

When replacing piston pin bushings, support the connecting rod in a press and press out the worn bushings. To install the new bushing, position the bushing on the connecting rod; make sure oil hole in bushing is in line with oil hole in connecting rod, then, use a bushing driver to press the new bushing into place. Ream the excess material from the bushing and, then, finish-hone the bushing to an inside diameter of 1.2505-1.2515 inches. Proper clearance between the piston pin and the piston pin bushing is 0.0005-0.00175 inch.

PISTON PINS

Piston pins are 1.24975-1.250 inches in diameter and are available only in standard size. The full-floating type piston pins are retained in the piston by the snap rings.

New pins fit from minus 0.00025 inch to plus 0.00025 inch clearance in the piston (thumb-press fit in piston at 140-160 degrees F.).

Fit new pins in connecting rod bushings to 0.0005-0.00175 inch clearance.

To install the piston pins, lubricate them with oil, then, heat the pistons in hot oil or water to 140-160 degrees F. and slide the piston pins in place by hand.

Install NEW snap rings when installing piston pins.

INSTALLING THE PISTON AND CONNECTING ROD ASSEMBLIES

1. Make sure the piston and connecting rod have been assembled correctly, with the word "Front" on top of the piston, toward the front of the engine, and the connecting rod location numbers opposite the camshaft.

> *NOTE: Engines with cast iron liners only -- if the old cylinder liners are going to be re-used, deglaze them, as outlined in Group 1, Section A, Part 4.*

2. Make sure all parts are clean, then, remove the bearing cap and apply a liberal coating of oil to the cylinder line bores and the piston assemblies.

3. Stagger the ring gaps, then, using a piston ring compressor, start the assembly into the cylinder liner bore. Make sure that the top of the piston marked "Front" is installed, as indicated, and that the piston and connecting rod assembly is installed in the proper cylinder location.

4. Rotate the crankshaft until the appropriate crankpin journal is at B.D.C., then, press the assembly into the cylinder bore.

5. Carefully clean the bearing bore in the connecting rod and the bearing insert, and install the upper insert in place.

6. Lubricate the bearing insert and crankpin journal, then, pull the rod assembly into position onto the crankpin, making sure that the bearing insert is still correctly located.

7. Carefully clean the connecting rod cap and the bottom bearing insert, and assemble it into the cap.

8. Lubricate the crankpin journal and the bottom insert.

9. With the cap location number opposite the camshaft side of the engine, position the cap in place and install the bolts, using new self-locking nuts. Tighten the connecting rod nuts to the appropriate torque, as listed below.

Early models with plain, self-locking nuts	65-70 ft.-lbs.
Late models with cadimum-plated, self-locking nuts	45-50 ft.-lbs.

> *NOTE: The top of the pistons, when installed, should be located within 0.0015-0.008 inch above the top of the cylinder block.*

CYLINDER LINERS

Two different types of cylinder liners have been used in the AD4.203 engines. Both cylinder liner arrangements are of the dry-type, but CANNOT be interchanged with one another.

Cylinder blocks, prior to engine serial no. 2939036, require chrome-plated cylinder liners and can be easily identified by the letters "CL" stamped before the engine serial number.

Cylinder blocks, starting with serial no. 2939036, have cast iron cylinder liners.

> *IMPORTANT: When replacing cylinder liners, make sure to install the type of liner for which the cylinder block was machined.*

Both types of cylinder liners are manufactured with an inside diameter of 3.6015-3.6025 inches.

The top of the cylinder liners are flanged and, when installed, must extend a specified distance below the face of the cylinder block. Replacement liners fit into the cylinder bores from 0.001 inch loose to 0.001 inch tight.

INSPECTING THE CYLINDER LINERS

> *NOTE: If a new piston is to be installed, then, it is advisable to install a new cylinder liner to that cylinder.*

1. Thoroughly clean the cylinder liners and inspect them for scoring or other damage.

2. If piston seizure has occurred, due to extreme overheating or other abnormal conditions, then, remove and discard the old cylinder liner and inspect the cylinder block bore for possible distortion, as outlined under the heading "Inspecting the Cylinder Block".

3. Measure the inside diameter of the cylinder liner at the upper portion of the piston ring travel area, and proceed, as follows:

a. CHROME-PLATED CYLINDER LINERS, ONLY — If the chrome-plated liners are worn to the point where ANY slight ridge can be detected, or if the chrome-plating appears to be worn and the inside diameter of the liner measures 3.604 inches, or more, the liners must be replace.

> *NOTE: The chrome-plating inside the cylinder liners is only 0.0015 inch thick, but is so extremely hard that it provides the liners with an exceptionally long life.*
>
> *DO NOT ATTEMPT TO DEGLAZE CHROME-PLATED LINERS.*

b. Cast iron cylinder liners, only — If the cast iron cylinder liners are worn to the point that the cylinder taper exceeds 0.008 inch, the liners must be replaced. If the amount of cylinder taper is within specifications and the liner appears serviceable, then, carefully remove any cylinder ridge present (if it was not removed earlier) and deglaze the liners before installing the piston and connecting rod assemblies.

REPLACING THE CYLINDER LINERS

To replace the cylinder liners, proceed, as follows:

1. Remove the piston and connecting rod assemblies.

2. Remove the studs from the face of the cylinder block.

3. Use a sleeve puller with puller plate MFN 8308 special tool and remove the cylinder liner from the top of the cylinder block, as shown in Fig. 26.

The diameter of the cylinder block bore is 3.6875-3.6885 inch. BE CAREFUL NOT TO DAMAGE THE CYLINDER BLOCK BORE.

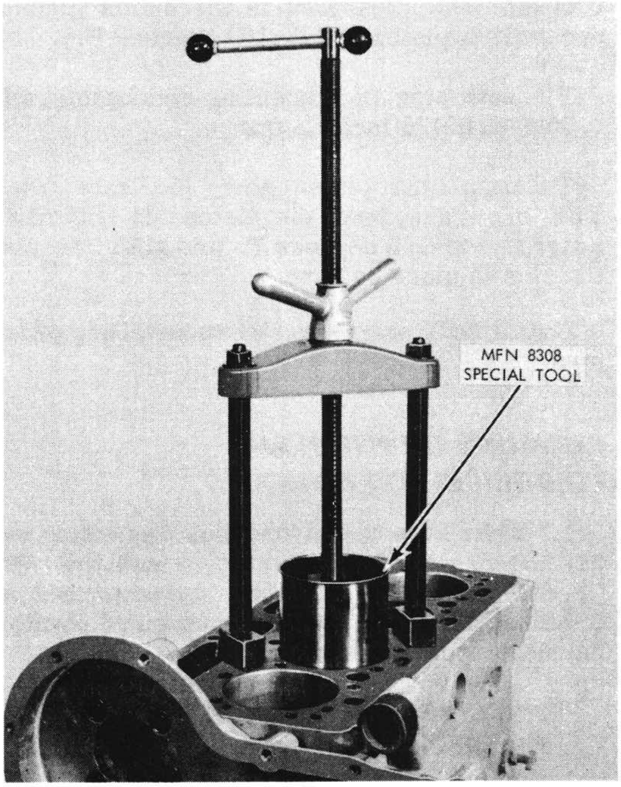

Fig. 26 – Removing Cylinder Liner

4. After removing the cylinder liner, THOROUGHLY clean the cylinder block bore, with particular attention given to the top recess for the flange of the liner.

After cleaning the cylinder block bore, check the complete liner contact area in the block to make sure it is free from burrs or damage. Remove any burrs present.

5. Carefully clean the cylinder liner. THIS IS VERY IMPORTANT. If kerosene is used to wash the liner, it is important that the liner be thoroughly dried before it is installed.

> *IMPORTANT: MAKE SURE THE BORE AND THE CYLINDER LINER ARE CLEAN. Also, care must be used in the handling of the liners, as the slightest damage or burr can cause considerable distortion to the liner when installed.*

6. Install replacement cylinder liners, as follows:

a. ENGINES WITH CHROME - PLATED CYLINDER LINERS -- If the old cylinder liners required replacement due to normal wear, then, chill the replacement liners and press them fully in place by hand. When correctly installed, the top face of the liner flange must be 0.001-0.009 inch below the top face of the cylinder block, as shown in Fig. 27.

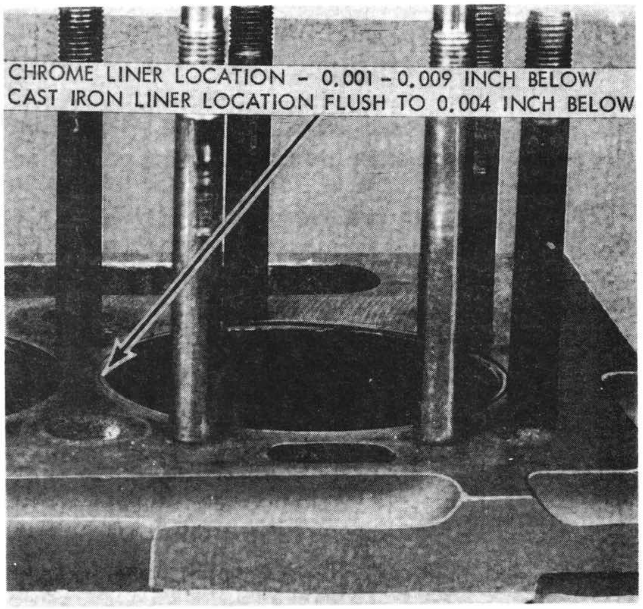
CHROME LINER LOCATION - 0.001 - 0.009 INCH BELOW
CAST IRON LINER LOCATION FLUSH TO 0.004 INCH BELOW

Fig. 27 – Cylinder Liners Must Be Located a Specified Distance Below Face of Cylinder Block

IF THE OLD CYLINDER LINER REQUIRED REPLACEMENT DUE TO SCORING OF THE PISTON, THEN, the following procedure should be used to install the new liners:

1. Check the cylinder block bore for possible distortion, as outlined under the heading "Inspecting the Cylinder Block".

2. Make sure the cylinder block bore and the cylinder liner are thoroughly cleaned, as outlined earlier, then, lightly lubricate the outside of the cylinder liner, using either clean hands or a pressure-type oil can. Avoid using a brush or a rag to apply the oil to prevent any possibility of foreign particles from getting onto the surface.

3. Selectively fit the replacement liner so that it will slide fairly free about three-quarters of the distance down the cylinder bore.

4. Press the liner fully into place BY HAND, so that the top of the liner flange is 0.001-0.009 inch below the top face of the cylinder block, as shown in Fig. 27.

SHOULD A LINER SLIDE IN PLACE UNDER ITS OWN WEIGHT, OR REQUIRE PUSHING IN WITH A PRESS, THE LINER WOULD NOT BE SUITABLE.

b. ENGINES WITH CAST IRON CYLINDER LINERS -- Make sure the cylinder block bore and the cylinder liners are thoroughly cleaned, as outlined, then, chill the liners and press them fully in place by hand. When correctly installed, the liner flange must be located flush with the top of the cylinder block to 0.004 inch below the face.

7. Make sure the cylinder liners are fully seated and allow a period of time for the liners to "settle in", then, measure the inside diameter of the liner to make sure there is no distortion present. Use either an inside micrometer or a dial indicator and check the inside diameter in two directions (at right angles) at the top, center and bottom of the bore. The cylinder liner should be concentric and measure from 3.6015-3.6025 inches in diameter. In the event the readings should indicate 0.0025 inch, or more, total distortion, the liner would be unsuitable for use.

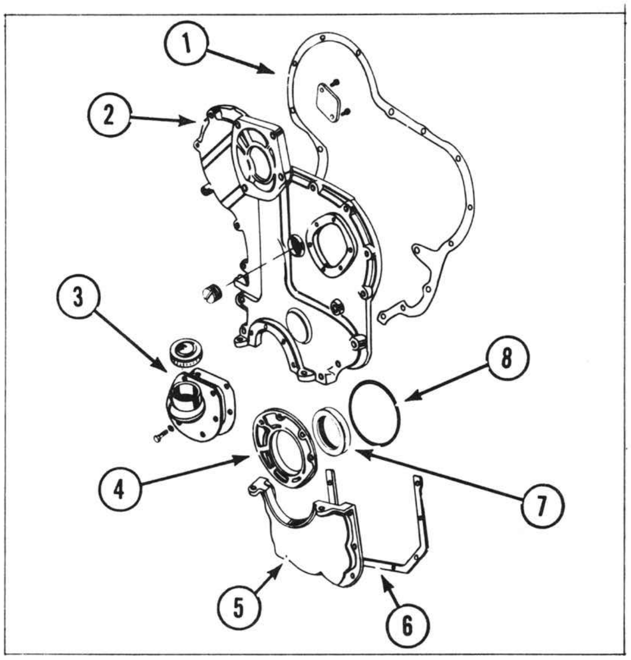

Fig. 28 – Timing Gear Cover and Front Crankshaft Oil Seal

1. Upper Timing Gear Cover Gasket
2. Upper Timing Gear Cover
3. Oil Filler Cover
4. Oil Seal Housing
5. Bottom Timing Gear Cover
6. Bottom Timing Gear Cover Gasket
7. Front Crankshaft Oil Seal
8. Oil Seal Housing "O" – Ring

TIMING GEAR COVER AND FRONT CRANKSHAFT OIL SEAL

The timing gear cover, as shown in Fig. 28, is made of die-cast aluminum and is a two-piece type cover. The cover is manufactured with an opening, which is covered by the oil filler cover assembly to allow easy removal of the bolts securing the injection pump to its gear.

The front crankshaft oil seal is of the spring-loaded type and is contained in an oil seal housing, which is bolted to the upper-half of the timing gear cover. The oil seal housing is provided with an "O"-ring around its outer diameter to prevent oil from leaking between the bore in the two halves of the timing cover and the outer diameter of the housing.

REMOVING THE TIMING GEAR COVER

1. Support the tractor under the oil pan and remove the front axle and radiator assembly.

2. Loosen the generator mounting bolts and remove the fan belt.

3. Loosen the clamps on the hoses from the water pump, except the by-pass hose; in this case, it is easier to remove the two setscrews securing the by-pass adapter to the thermostat housing.

4. Disconnect the hose from the water pump to the cylinder block, at the cylinder block end.

5. Remove the crankshaft pulley setscrew and washer. The setscrew has a normal right-hand thread.

6. Remove the crankshaft pulley, which is a slide-fit and keyed to the crankshaft.

7. Disconnect and remove the engine breath-pipe and top hose.

8. Remove the water pump.

9. Remove the two setscrews (one on each side of the crankshaft) securing the two halves of the timing gear cover together.

NOTE: The oil seal housing is not attached to the bottom half of the timing cover and may remain attached to the upper half, or it can be removed by, first, removing the four setscrews with the special copper washers.

10. Remove the setscrews securing the upper half of the timing cover to the timing gear housing.

NOTE: The three bolts directly below the oil filler cover pass through the timing gear housing and secure the hydraulic pump for power steering model tractors.

11. Remove the upper half of the timing cover. If the oil seal housing is still attached to the timing cover, be careful not to damage the seal on the key in the crankshaft.

12. If the front crankshaft oil seal was leaking oil, or if a major engine overhaul is to be performed, then, remove the setscrews securing the bottom half of the timing cover and remove the cover from the oil pan.

INSTALLING THE TIMING GEAR COVER

1. Carefully clean all of the gasket sealing surfaces and install new gaskets.

2. **LOOSELY** install the upper half of the timing gear cover without the oil seal housing attached to it. Do not fully tighten any of the setscrews in the upper half at this time.

3. LOOSELY install the bottom half of the timing gear cover to the oil pan. If it is already attached to the oil pan, then, loosen the setscrews and free the cover.

4. Position the upper and lower halves of the timing cover so that the bore in the two halves for the oil seal housing will be aligned. THERE MUST NOT BE ANY STEP IN THE BORE BETWEEN THE UPPER AND LOWER HALVES OF THE COVER.

5. Partially tighten the two halves to the timing gear housing and oil pan by the setscrews located near the butt faces of the covers. Tighten these four setscrews sufficiently tight to hold the two halves to the housing and oil pan, and yet, allow an up and down movement.

6. Install and tighten the two setscrews which clamp the two halves of the cover together.

7. Release the four setscrews securing the two halves to the housing and oil pan to assure up and down movement of the covers which are now bolted together.

8. Install a new "O"-ring in the groove of the oil seal housing. Make sure the "O"-ring is not twisted.

9. Lubricate the "O"-ring lightly and carefully install the oil seal housing complete with the new seal in the bore of the covers. Install the four setscrews with the special sealing washers and tighten them at this time to secure the oil seal housing in place.

10. Install MFN 747 special tool onto the crankshaft and locate it in the front of the oil seal housing bore to correctly locate the timing gear cover and the oil seal in relation to the crankshaft.

11. Secure both halves of the timing cover to the timing gear housing and oil pan.

12. Remove the special tool, then, install the water pump, engine breather pipe, generator adjusting link and fan belt.

13. Install the crankshaft pulley and secure it with its setscrew and washer.

14. Complete reassembly by reversing the disassembly procedure.

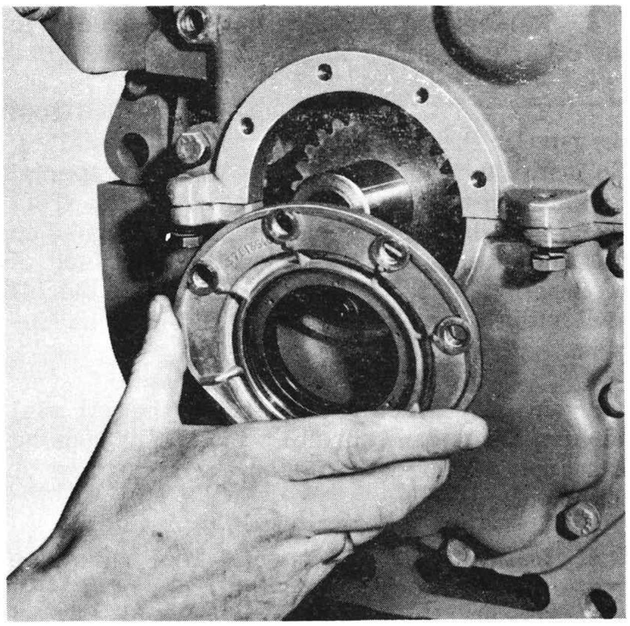

Fig. 29 – Removing the Front Crankshaft Oil Seal and Housing

REPLACING THE FRONT CRANKSHAFT OIL SEAL

1. Remove the crankshaft pulley and release the two setscrews, located on each side of the crankshaft, which clamp the two halves of the timing cover together.

2. Remove the four setscrews and special sealing washers securing the oil seal housing to the top half of the timing cover and remove the oil seal housing, as shown in Fig. 29.

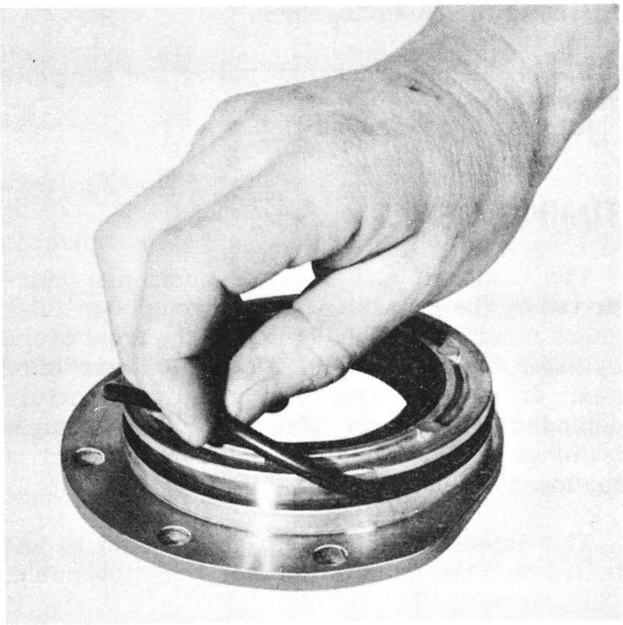

Fig. 30 – Removing "O" – Ring from Oil Seal Housing

3. Remove the "O"-ring from the groove in the oil seal housing, as shown in Fig. 30.

4. The old oil seal can now be removed from the bore in the housing and a new seal installed. To install a new oil seal, use MFN 747 special tool and press the seal in place from the front of the housing. The special tool is designed to locate the oil seal 3/32" below the front face of the housing bore. Make sure to install the oil seal with the lip of the seal TOWARD the engine.

5. Install a new "O"-ring in the oil seal housing groove and carefully install the housing in place. Do not fully tighten the setscrews at this time.

6. Install MFN 747 special tool onto the crankshaft and locate it in the front of the oil seal housing bore to correctly locate the oil seal and housing in relation to the crankshaft. IF THE TIMING GEAR COVER IS PROPERLY LOCATED, IT SHOULD NOT REQUIRE ANY FORCE TO ALIGN THE OIL SEAL AND HOUSING.

If it is necessary to use force to obtain alignment of oil seal housing with crankshaft, it is an indication that the timing gear cover is improperly positioned.

7. Fully tighten the four setscrews securing the oil seal housing to the upper half of the timing gear cover.

8. Tighten the two setscrews clamping the halves of the cover together.

9. Install the crankshaft pulley and complete reassembly.

TIMING GEARS

The camshaft and injection pump are gear-driven by the crankshaft gear through two idler gears mounted on hubs bolted to the front of the cylinder block; see Fig. 31. The lower idler gear drives the hydraulic pump for tractors equipped with power steering. Two flanged bushings are installed into the front and rear of the lower idler gear.

The injection pump gear is doweled to and bolted onto the front of the fuel injection pump.

All of the timing gears are marked and, when reassembling the engine, all marks must align with No. 1 piston at T. D. C. on compression stroke; see No. 1, Fig. 31. Replacement gears have timing marks and are available in standard size only.

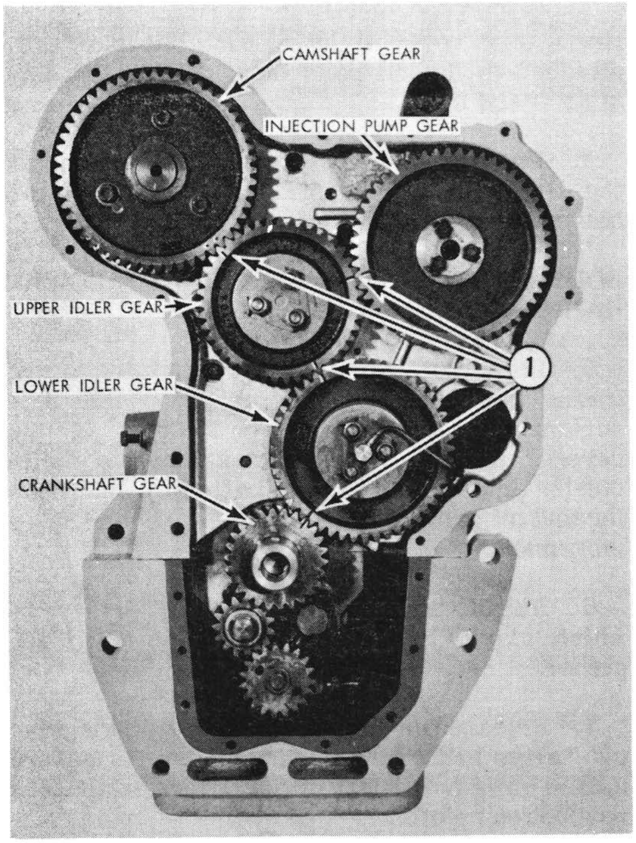

Fig. 31 – Timing Gear Marks Properly Aligned
1. Timing Marks

NOTE: Due to the odd number of teeth in the two idler gears, the complete set of timing gear marks will not align every time that No. 1 cylinder is at T. D. C. on compression stroke.

CHECKING THE TIMING GEAR BACKLASH

To check timing gear backlash, proceed, as follows:

1. Remove the timing gear cover.

2. Check the backlash between the timing gears with a feeler gauge or a dial indicator, as shown in Fig. 32. The backlash between any two gears in the timing gear train must be between 0. 003-0. 006 inch.

3. If the backlash of the timing gears is not within these limits, the gears should be replaced. Replacement gears are available only

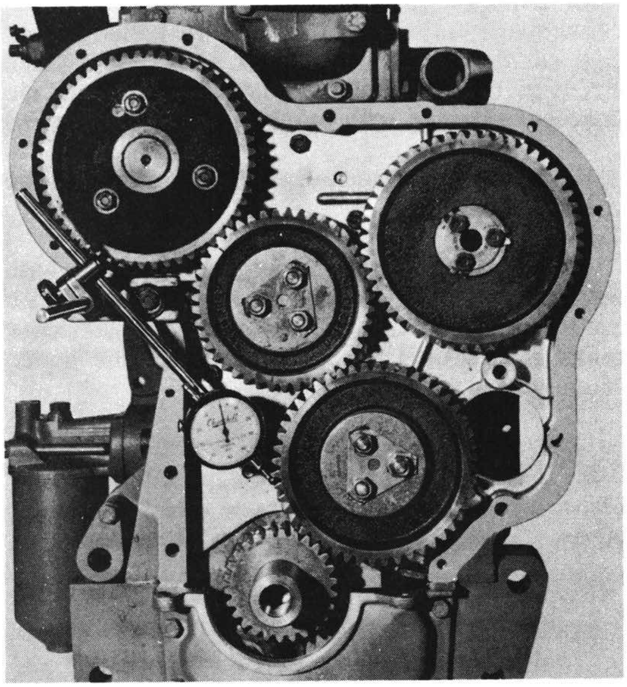

Fig. 32 – Measuring Timing Gear Backlash

in standard size and are marked for correct installation.

REMOVAL OF IDLER GEARS AND HUBS

To remove the idler gears and hubs, refer to Fig. 33, and proceed, as follows:

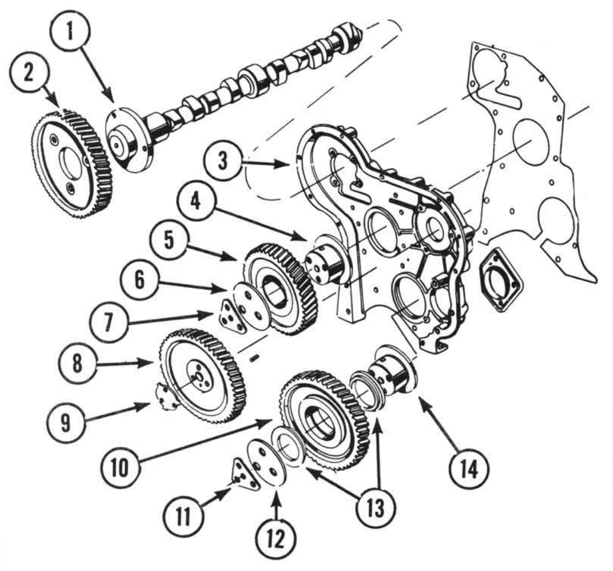

Fig. 33 – Timing Gears – Identification and Sequence of Parts

1. Camshaft
2. Camshaft Gear
3. Timing Gear Housing
4. Idler Gear Hub
5. Upper Idler Gear
6. Idler Gear Retaining Plate
7. Idler Gear Lock Plate
8. Injection Pump Drive Gear
9. Injection PumpDrive Gear Lock
10. Lower Idler Gear
11. Idler Gear Lock Plate
12. Idler Gear Retaining Plate
13. Lower Idler Gear Bushing
14. Idler Gear Hub

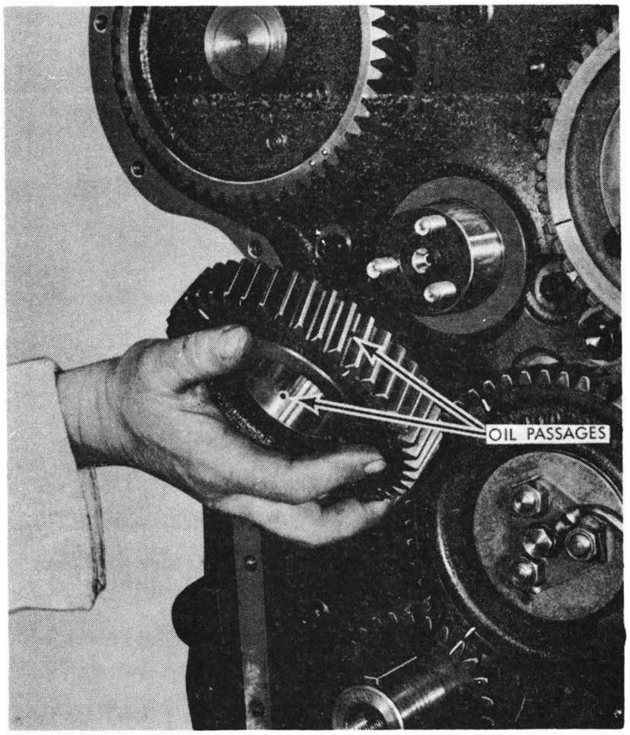

Fig. 34 – Removing or Installing the Upper Idler Gear

1. If the lower idler gear is equipped with an oil spray pipe, remove the lock wire on the banjo-type bolt securing the oil line (not shown in Fig. 33) to the lower idler gear hub, then, remove the banjo bolt and oil line.

2. Unlock and remove the three nuts securing the retaining plate.

3. Remove the lock plate, No. 11, Fig. 33, and the idler gear retaining plate, No. 12, Fig. 33.

4. Remove the lower idler gear.

5. Remove the upper idler gear in a similar manner, as shown in Fig. 34.

6. The idler gear hubs may now be removed from the studs located in the front of the cylinder block; refer to Fig. 35.

INSPECTING THE IDLER GEARS AND HUBS

Discard any parts that are worn or damaged; make sure the oil holes in the upper idler gear and the oil holes for each of the idle gear hubs are open and clean; refer to Fig. 34 and 35.

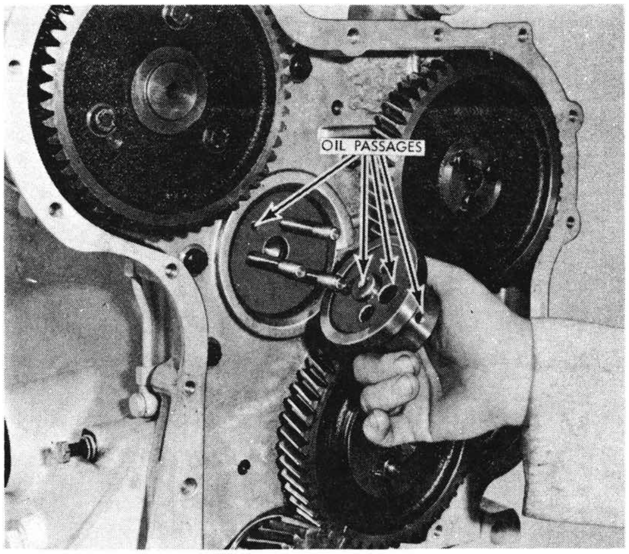

Fig. 35 – Removing or Installing the Upper Idler Gear Hub

UPPER IDLER GEAR AND HUB:

Hub Diameter	1.996-1.997 inches
Gear Bore Diameter	1.9998-2.0007 inches
Clearance (gear-to-hub)	0.0028-0.0047 inch
Gear End-Play	0.002-0.004 inch

LOWER IDLER GEAR AND HUB:

Hub Diameter	1.996-1.997 inches
Bushing Bore Diameter	1.9998-2.0007 inches
Clearance (gear-to-hub)	0.0028-0.0047 inch
Gear End-Play	0.002-0.004 inch

INSTALLING THE IDLER GEARS AND RETIMING THE ENGINE

To install the idler gears and hubs, and to time the engine with the camshaft gear, crankshaft gear and injection pump gear installed, proceed, as follows:

1. Install the upper and lower idler gear hubs.

> *NOTE: The hubs are interchangeable, but fit on the three studs in only one position. The boss at the rear of the hub locates in the machined face of the cylinder block.*

2. Turn the crankshaft until the mark on the crankshaft timing gear aligns with the center line of the lower idler gear hub. (No. 1 and No. 4 pistons on T. D. C. and T. D. C. mark on flywheel aligning with mark on inspection hole.)

3. Remove the rocker cover and release the rocker assembly.

4. Install the lower idler gear (the gear with bushings) so that one timing mark aligns with the mark on the crankshaft gear and the other mark aligns with the center line of the upper idler gear hub.

5. Install the lower idler gear retaining plate, which will only fit in one position on the studs. Lock the three nuts in position.

> *NOTE: If the lower idler gear is equipped with an oil spray pipe, install the oil line to the retaining plate with the banjo-bolt. Lock the bolt with wire and install the small rubber washer on the end of the oil pipe.*

6. Turn the camshaft gear and the injection pump drive gear so that their timing marks are approximately aligned with the center of the upper idler gear hub.

7. Install the upper idler gear so that the three timing marks align with the marks on the camshaft gear, injection pump gear and lower idler gear.

8. Make sure all of the timing gear marks are aligned, as shown in Fig. 31, then, install the upper idler gear retaining plate and lock the three nuts in position.

9. Secure the rocker assembly in position, then, adjust the valves and complete reassembly.

REMOVING THE CAMSHAFT GEAR

1. Release the rocker arm shaft assembly and remove the upper idler gear.

2. Remove the three setscrews and shakeproof washers securing the camshaft gear.

3. Remove the camshaft gear, as shown in Fig. 36.

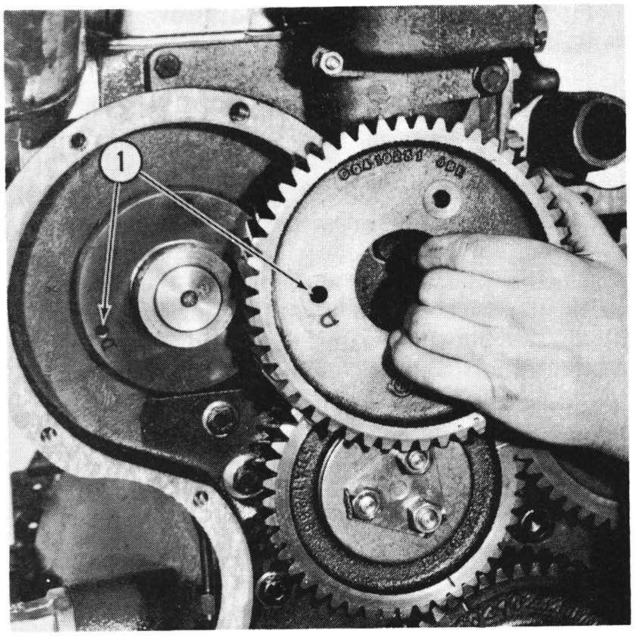

Fig. 36 – Camshaft Gear and Hub Marked for Correct Installation

1. Holes Marked "D" Must Align when Installing Gear

INSTALLING THE CAMSHAFT GEAR

1. Observe on the hub of the camshaft and on the front of the camshaft gear the bolt holes with the letter "D" stamped next to them, as shown in Fig. 36.

2. Install the camshaft gear onto the camshaft, making sure that the marked holes (with the letter "D" stamped next to them) are aligned. Tighten the setscrews and the shakeproof washers securely.

3. Install the upper idler gear with all timing marks aligned, then, secure the rocker arm shaft assembly in place and complete reassembly.

REMOVING THE INJECTION PUMP DRIVE GEAR

1. Release the rocker arm shaft assembly and remove the upper idler gear.

2. Release the lock tabs for the three setscrews securing the injection pump drive gear to the injection pump.

3. Remove the injection pump gear, as shown in Fig. 37.

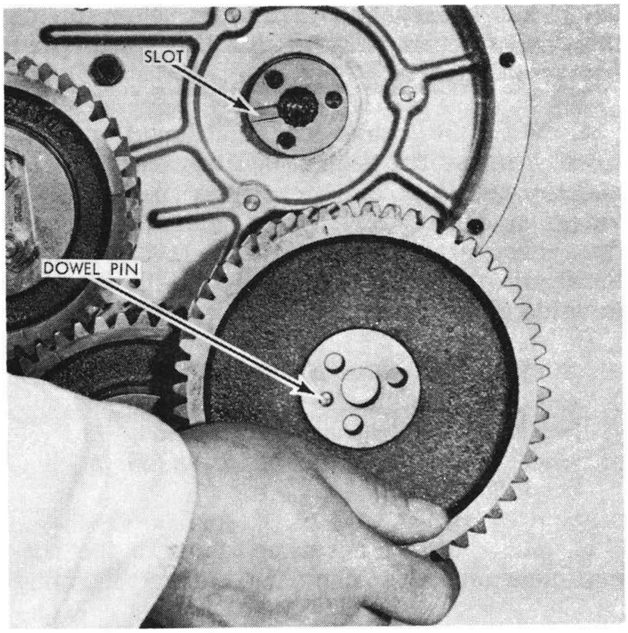

Fig. 37 – Removing or Installing the Injection Pump Drive Gear

INSTALLING THE INJECTION PUMP DRIVE GEAR

1. Align the dowel in the injection pump gear with the slot in the front of the injection pump and position the gear in place; refer to Fig. 37.

2. Using a new lock plate, install the three setscrews securing the gear in place and tighten them. Lock the setscrews by bending over the tabs of the lock plate.

3. Install the upper idler gear with all timing marks aligned, then, secure the rocker arm shaft assembly in place and complete reassembly.

CHECKING VALVE TIMING

To check the valve timing of the engine, proceed, as follows:

1. Turn the crankshaft until rocker arms of No. 4 cylinder start "rocking" (No. 1 piston at approximately T. D. C. on compression stroke).

2. With No. 1 cylinder at T. D. C. on compression stroke, adjust the tappet for the intake valve of No. 1 cylinder so that there is 0.043 inch clearance between the valve and the rocker arm.

3. Turn the crankshaft in the normal direction of engine rotation (clockwise) until the

0.043 inch clearance is taken up. Stop turning the crankshaft the instant that the rocker arm contacts the valve.

4. With the crankshaft positioned, as outlined, remove the inspection plug from the inspection window in the adapter plate. If the valves are properly timed and the procedure properly followed, the T.D.C. mark on the flywheel should be aligned with the mark on the side of the inspection window.

> *NOTE: The valve timing may be considered satisfactory if the T.D.C. mark on the flywheel is less than 1/3 inch away from the mark on the inspection window.*

5. Make sure to reset the tappet to the normal clearance after checking the valve timing.

CAMSHAFT

The camshaft is made of heavy-duty iron with chill-hardened cams and is mounted high on the right-hand side of the cylinder block, in such a position that it does not require the use of push rods. The camshaft is supported by three bearings machined directly into the cylinder block. Camshaft end-play is controlled by a 360 degree thrust plate located in a recess in the front of the cylinder block and by a boss on the inside of the timing gear cover.

REMOVING THE CAMSHAFT

To remove the camshaft, proceed, as follows:

1. Remove the timing gear cover and fuel tank.

2. Turn the engine until No. 1 piston is at T.D.C. on compression stroke.

3. Remove the rocker shaft assembly, fuel lift pump and idler gears.

4. Lift the tappets and remove the camshaft (with or without its gear) from the cylinder block, as shown in Fig. 38, using care not to damage the journals, cams, or the tappets.

INSPECTING THE CAMSHAFT

The camshaft should be inspected, as follows:

1. Inspect the camshaft journals and lobes. If the journals are excessively scored, nicked or discolored by heat, or if the lobes are pitted, or rough, the camshaft should be replaced.

2. Measure the diameter of the bearing journals for wear and out-of-round with a micrometer. If journal diameters are worn, or out-of-round, or if the camshaft lobes are worn, the camshaft should be replaced.

New camshaft specifications are, as follows:

Front Journal	1.869-1.870 inches
Center Journal	1.859-1.860 inches
Rear Journal	1.839-1.840 inches
Cam Lift (intake and exhaust). . .	0.3085-0.3165 inch

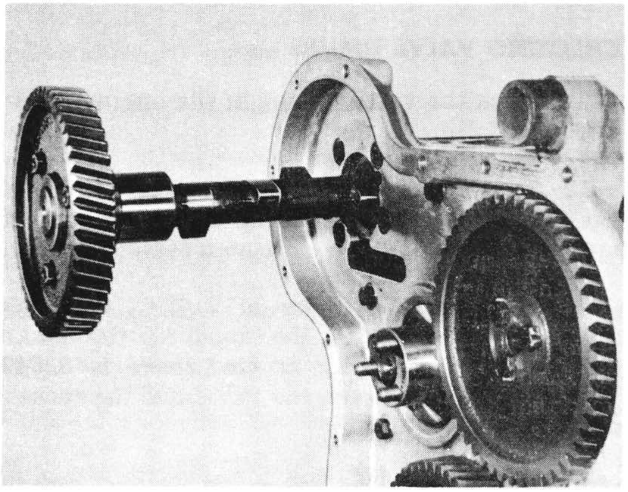

Fig. 38 – Removing or Installing the Camshaft

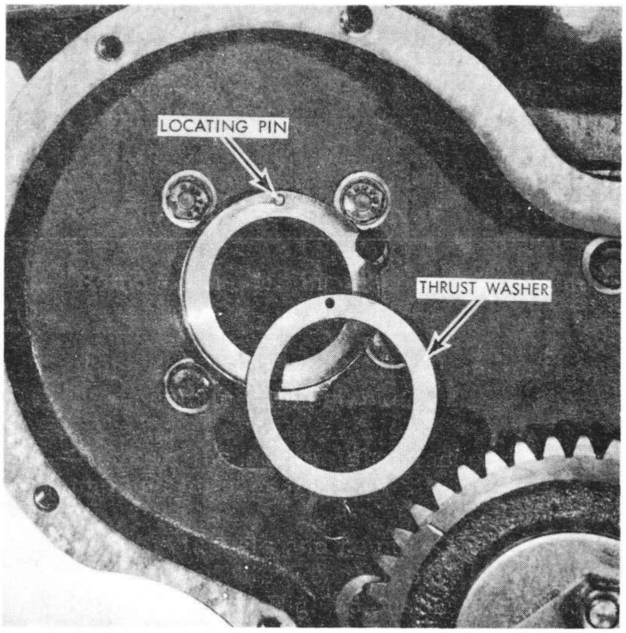

Fig. 39 – Camshaft Thrust Washer and Locating Pin

3. Measure the camshaft bearing bores in the block with a hole gauge and micrometer. Then, compare each bore diameter to its mating journal diameter. Correct clearance between the camshaft bearing journals and the camshaft bores is 0.004-0.008 inch.

4. Remove the camshaft thrust plate, shown in Fig. 39, and measure its thickness. Replace the thrust plate if its thickness is less than 0.125 inch, or if, when installed into its recess, it is positioned more than 0.003 inch below the face of the block.

> *NOTE: The thrust washer may be located from 0.008 inch ahead of the block face to 0.003 inch below the block face.*

INSTALLING THE CAMSHAFT

> *NOTE: If the camshaft gear has been removed from the camshaft, make sure to install it to the camshaft with the letters "D" in alignment. Refer to heading "Installing the Camshaft Gear" for additional information.*

1. With the tappets supported in their raised position, slowly turn the camshaft and carefully install it into the cylinder block. Make sure the camshaft thrust plate is correctly located before fully installing the camshaft.

2. Install the idler gears with all timing marks aligned, then, install the rocker arm shaft assembly and adjust the tappets.

3. Install the fuel lift pump, rocker arm cover, timing gear cover, and complete reassembly.

CRANKSHAFT AND MAIN BEARINGS

The crankshaft is machined from a solid nickel chrome molybdenum steel forging and is induction-hardened for maximum service. The crankshaft is supported by five precision non-adjustable-type main bearings, as shown in Fig. 40.

The rear of the crankshaft is machined to provide an oil thrower and oil return scroll.

New specifications are, as follows:

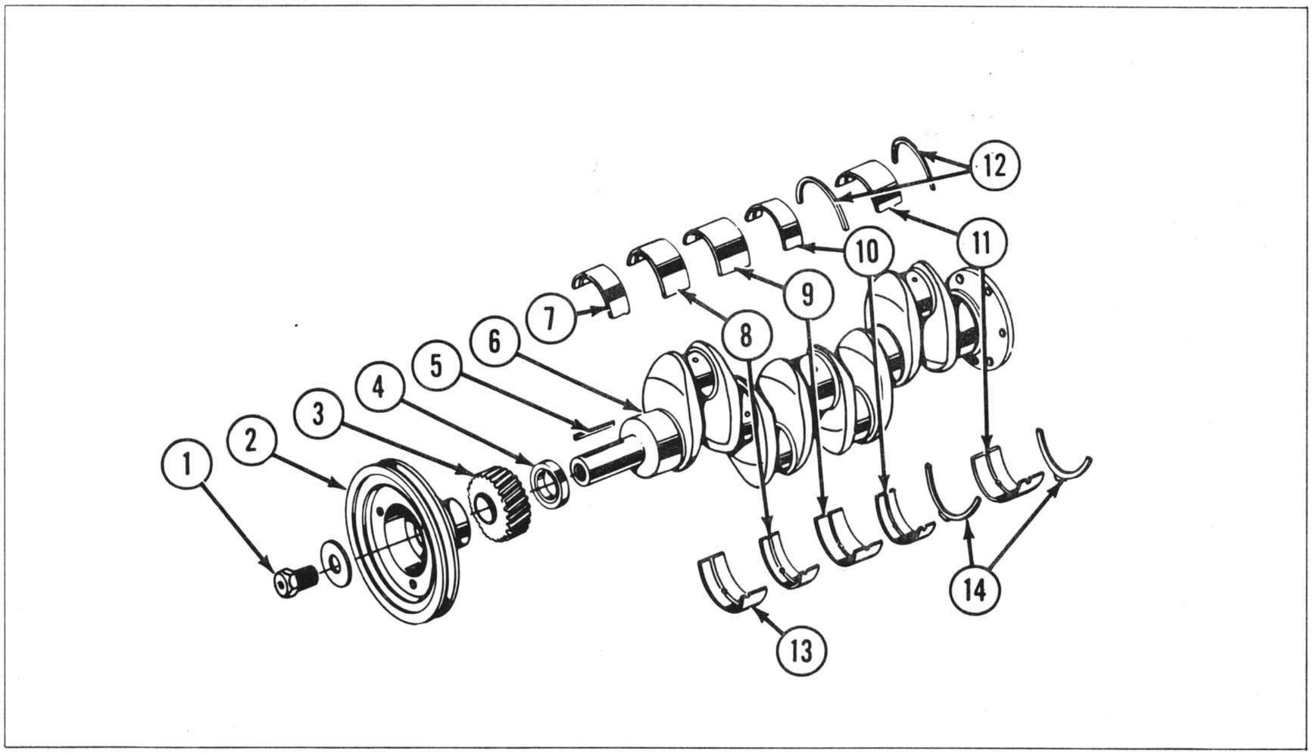

Fig. 40 – Crankshaft – Identification and Sequence of Parts

1. Pulley Retaining Bolt
2. Crankshaft Pulley
3. Crankshaft Timing Gear
4. Timing Gear Spacer
5. Timing Gear Key
6. Crankshaft
7. Front Bearing Insert (Upper Half)
8. No. 2 Bearing Inserts
9. No. 3 Bearing Inserts
10. No. 4 Bearing Inserts
11. No. 5 Bearing Inserts
12. Upper Thrust Washers
13. Front Bearing Insert (Lower Half)
14. Lower Thrust Washers

CRANKSHAFT:

Main Bearing Journal Diameter	2.7485-2.749 inches
Crankpin Diameter	2.2485-2.249 inches
Crankshaft End-Play	0.002-0.014 inch

MAIN BEARINGS:

Bearing Clearance Limits	0.003-0.005 inch
Diameter of Bearing Bore in Block	2.9165-2.9175 inches

Oil seals are provided at the front and rear ends of the crankshaft. The front oil seal, as shown in Fig. 29, is of the spring-loaded type and is installed in an oil seal housing, which is bolted to the timing gear cover. The rear seal is of the rubber core asbestos rope type and is contained in a two-piece seal retainer, which is bolted to the rear face of the cylinder block and the oil pan seal housing.

The doweled main bearing caps are numbered from front to rear AND CANNOT BE INTERCHANGED OR REPLACED.

> *NOTE: The main bearing bores in the cylinder block and bearing caps are machined with the caps in place and are stamped with an identification number. If, for any reason, a main bearing cap becomes damaged, it will be necessary to replace the cylinder block complete with main bearing caps.*

Main bearing inserts are available in standard size, or 0.010 inch, 0.020 inch and 0.030 inch undersize. Upper and lower main bearing inserts are interchangeable for each bearing, EXCEPT the front.

Crankshaft end-play is controlled by thrust washers, No's. 12 and 14, Fig. 40, which are installed in the block and rear main bearing cap.

CRANKSHAFT END-PLAY

Crankshaft end-play is controlled by replaceable thrust washers, which are installed in recesses on the sides of the rear main bearing cap and bearing bore in the cylinder block. The lower halves of the thrust washers (which fit in the bearing cap) have locating lugs to prevent them from turning out of position.

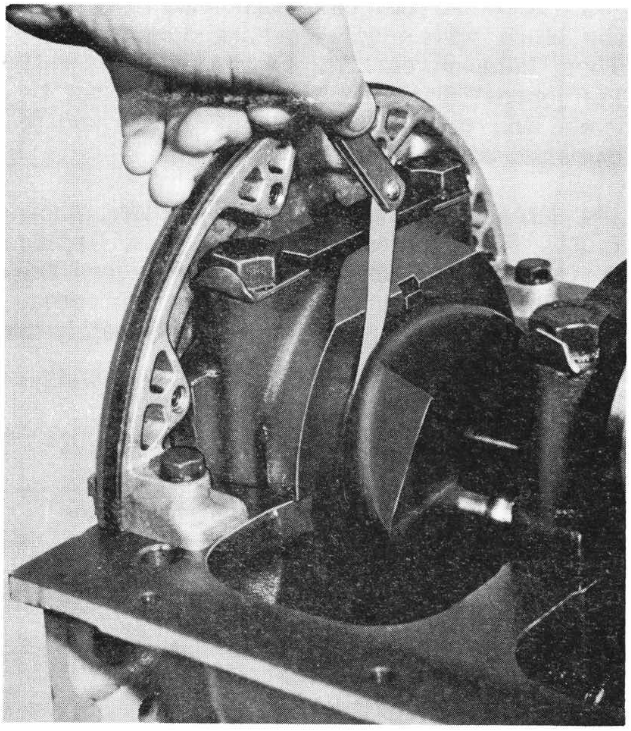

Fig. 41 – Measuring Crankshaft End Play

> *NOTE: Replacement thrust washers are available in standard size or 0.007 inch oversized.*

To determine the amount of crankshaft end-play, proceed, as follows:

1. Using care not to damage the crankshaft, force the crankshaft forward as far as it will go.

2. Measure the gap between the machined shoulder on the crankshaft web and the crankshaft thrust washer with a dial indicator or feeler gauge, as shown in Fig. 41.

3. End-play should be within 0.0002-0.014 inch. Install new thrust washers, if end-play exceeds 0.014 inch.

Replacing Thrust Washers

To replace worn thrust washers, proceed, as follows:

1. Remove the rear main bearing cap.

2. Rotate the old upper halves of the thrust washers out of the recesses in the cylinder block.

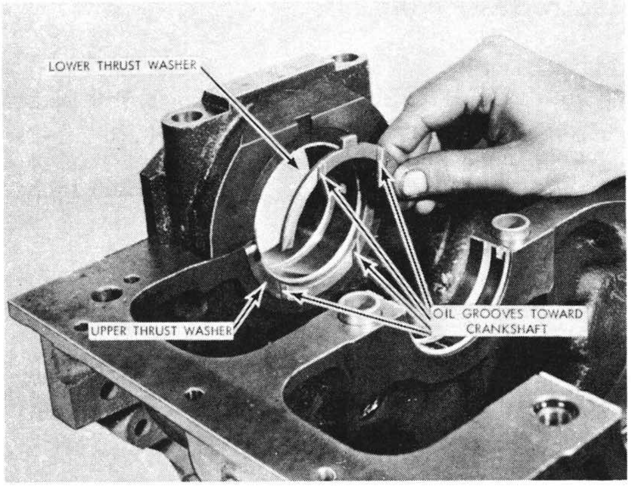

Fig. 42 – Crankshaft Thrust Washers

3. Lubricate the new upper halves of the thrust washers (Those without locating lugs) and rotate them into place WITH THE VERTICAL GROOVES FACING OUTWARD, refer to Fig. 42.

4. Remove the old lower halves of the thrust washers from the bearing cap and install the new ones with the vertical grooves facing outward.

> *NOTE: A light coating of grease will assist in holding the washers in place. Make sure all of the thrust washers are installed with the vertical grooves outward. (Bronze faces toward crankshaft.)*

5. Using new locks, install the rear main bearing cap, then, tighten the bearing capscrews to 110-120 ft.-lbs. torque and recheck crankshaft end-play.

> *NOTE: If there is a shim washer fitted between the lock and the main bearing capscrew, tighten the capscrews to 90-95 ft.-lbs. torque.*

REMOVING THE CRANKSHAFT

1. Separate the engine from the tractor, including the front axle.

2. Remove the clutch assembly, flywheel, starter motor, and transmission housing adapter plate.

3. Remove the crankshaft pulley and bottom half of the timing gear cover.

4. Remove the front crankshaft oil seal housing, also, the oil pan and oil pump suction and delivery pipes.

5. Remove the setscrews securing the two halves of the rear oil seal retainer assembly, then, remove the retainers.

6. Remove the oil pan seal housing from the rear of the cylinder block and remove the old gasket from its groove in the housing.

7. Remove the connecting rod caps and bearing inserts.

> *NOTE: Using care not to damage the crankshaft, force the crankshaft forward, then, measure crankshaft end-play, using a dial indicator or feeler gauge, as shown in Fig. 41. If end-play exceeds 0.014 inch, install new thrust washers when assembling engine.*

8. Release the main bearing locks and remove setscrews securing the main bearing caps.

9. Remove the main bearing caps, using care not to drop either the bearing inserts or thrust washers.

> *NOTE: The oil pump may remain bolted to the front main bearing cap, as shown in Fig. 43.*

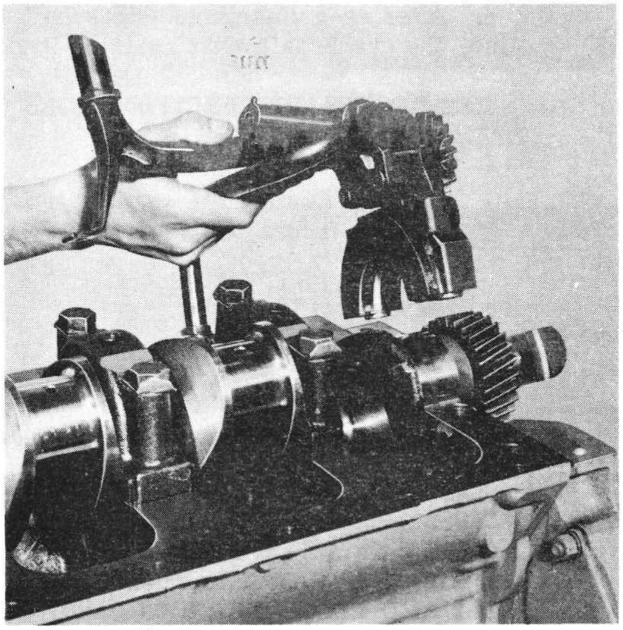

Fig. 43 – Removing Front Main Bearing Cap with Oil Pump Attached

10. Carefully lift the crankshaft from the cylinder block.

11. Remove the crankshaft timing gear and spacer.

> *NOTE: Make sure all main bearing inserts and caps are identified so that, if serviceable, they may be installed in their original location.*

INSPECTING THE CRANKSHAFT

Thoroughly clean and inspect all parts. MAKE SURE ALL OIL PASSAGES HAVE BEEN CAREFULLY CLEANED AND BLOWN OUT WITH COMPRESSED AIR.

Inspect the crankshaft, as outlined in Group 1, Section A, Part 4.

CRANKSHAFT:

Main Bearing Journal Diameter	2.7485-2.749 inches
Crankshaft End-Play	0.002-0.014 inch
Crankpin Journal Diameter	2.2485-2.249 inches

MAIN BEARINGS:

Diameter of Bearing Bore in Block	2.9165-2.9175 inches
Bearing Clearance	0.003-0.005 inch

If any of the main or crankpin journals are worn beyond specifications, more than 0.0015 inch out-of-round, or tapered more than 0.001 inch, the crankshaft should either be replaced or re-ground and fitted with undersize bearings.

REGRINDING THE CRANKSHAFT

To properly re-grind the crankshaft, follow the information and specifications given below:

1. Measure the main bearing and crankpin journal diameters to determine the next size they can be ground to and fitted with undersize bearing inserts.

2. Inspect the crankshaft for cracks.

3. If the crankshaft has been magnetized, make sure to demagnetize it before it is re-ground.

4. After re-grinding the crankshaft, remove the sharp corners on the oil holes. Also, the crankshaft must again be inspected for cracks, then, demagnetized.

THE NECESSARY SPECIFICATIONS FOR RE-GRINDING THE CRANKSHAFT JOURNALS ARE, AS FOLLOWS:

> *IMPORTANT: The surface finish on all bearing surfaces should be 16 micro-inches, as measured by a propilometer, and no coarser. Also, it is very important to maintain the radii quoted on the main bearing and crankpin journals.*

MAIN BEARING JOURNAL DIAMETERS:

Standard Size	2.7485-2.749 inches
Undersizes:	
0.010 Inch	2.7385-2.739 inches
0.020 Inch	2.7285-2.729 inches
0.030 Inch	2.7185-2.719 inches
NO. 1 FRONT MAIN BEARING JOURNAL WIDTH	1.4219 inches (1-27/64 inches)
NO. 2 AND 4 MAIN BEARING JOURNAL WIDTHS	1.2147-1.2227 inches
NO. 3 MAIN BEARING JOURNAL WIDTH	1.8397-1.8477 inches
NO. 5 MAIN BEARING JOURNAL WIDTH	1.87425-1.87625 inches

RADII ON NO. 3 (CENTER) AND NO. 5 (REAR) MAIN BEARING JOURNALS	0.125-0.135 inch

NOTE: These radii must be burnished-rolled with a load of 400 lbs. on the shoe for 45 seconds at 150 RPM, after polishing.

RADII ON REMAINING MAIN BEARING JOURNALS	0.0938-0.1094 inch

CRANKPIN JOURNAL DIAMETERS:

Standard Size	2.2485-2.249 inches
Undersizes:	
0.010 Inch	2.2385-2.239 inches
0.020 Inch	2.2285-2.229 inches
0.030 Inch	2.2185-2.219 inches
CRANKPIN JOURNAL WIDTHS:	
Standard Size	1.562-1.5635 inches
Maximum Permissable Width After Re-grinding	1.5785 inches
RADII ON ALL CRANKPIN JOURNALS	0.1563-0.1719 inch

INSTALLING THE CRANKSHAFT

To install the crankshaft, make sure all of the oil passages are open and clean and that the crankshaft and the main bearing bores in the block are clean, then, proceed, as follows:

1. Install the upper halves of the main bearing inserts in their proper positions and lubricate them.

NOTE: New main bearing inserts are not completely interchangeable. Refer to the following table to determine which inserts are interchangeable.

BEARING INSERTS	NO. OF INSERTS
No. 3 and No. 5 (rear) Bearing-Upper and Lower Halves	4
No. 1 Bearing-Upper Half, Only	1
No. 1 Bearing-Lower Half, Only	1
No. 2 and No. 4 Bearing, Upper and Lower Halves	4

2. Install the upper halves of the crankshaft thrust washers (those without locating tabs) on each side of the rear wall of the cylinder block housing, with the bronze face (grooved side) toward the crankshaft and the steel face toward the main bearing cap; refer to Fig. 42.

NOTE: A light coat of grease will assist in holding the thrust washers in place until the crankshaft is installed.

3. Make sure that:

a. The main bearing inserts are correctly installed.

b. Bronze faces of thrust washers are toward crankshaft.

4. Carefully lower the crankshaft into position.

5. Install the lower main bearing inserts into their respective bearing caps and lightly coat them with oil.

6. Lightly coat the lower rear main bearing thrust washers (those with locating tabs) with grease and position them in the recess on each side of the rear bearing cap. MAKE SURE THAT THE GROOVED FACE IS TOWARD THE CRANKSHAFT.

7. USING NEW LOCKS, install the numbered main bearing caps in their correct locations. Make sure the bearing caps are properly located. TORQUE MAIN BEARINGS TO 110-120 FT.-LBS. AND LOCK THE SETSCREWS.

NOTE: Late model engines are equipped with a shim washer between the head of the main bearing setscrews and the locks. The shim washers help prevent the locks from turning when tightening the setscrews.

If the engine is provided with shim washers, or if their use is desired, tighten the main bearing setscrews to 90-95 ft.-lbs. torque.

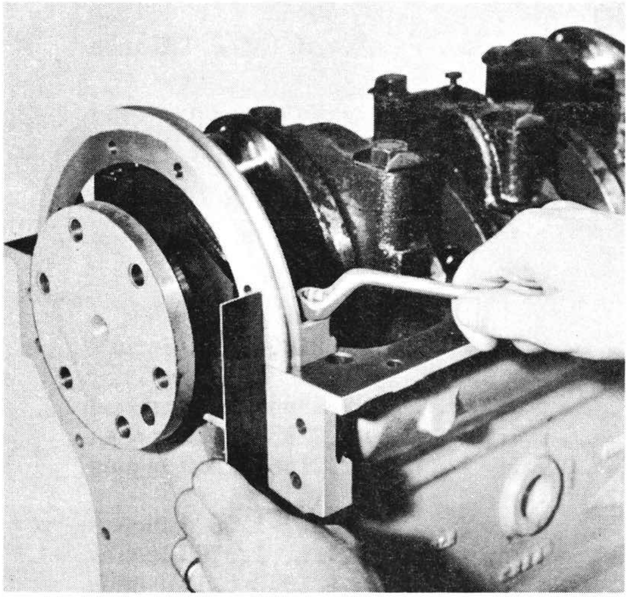

Fig. 44 – Installing the Oil Pan Seal Housing

8. Using care not to damage the crankshaft, force the crankshaft forward, then, measure crankshaft end-play, using a dial indicator or feeler gauge, as shown in Fig. 41. End-play should be between 0.002-0.014 inch. If end-play exceeds 0.014 inch, install new thrust washers.

9. Install the oil pan seal housing onto the cylinder block and align it so that the rear face of the housing is flush with the rear face of the cylinder block, as shown in Fig. 44.

10. Install the two rear crankshaft oil seal retainers with new oil seals and complete reassembly of engine, using new gaskets and seals.

REAR CRANKSHAFT OIL SEAL

The rubber-cored asbestos type oil seals are contained in a two-piece retainer cover assembly which is bolted to the rear face of the cylinder block and the oil pan seal housing. Each half of the oil seal retainer is machined to accommodate the oil seal. New oil seals can be installed with the crankshaft in position after the transmission adapter plate has been removed.

> *NOTE: Whenever oil leaks are encountered around the rear of the engine, do not immediately assume the rear crankshaft oil seal is at fault. In many cases where the oil seal has been suspected, it has been found that the oil leakage was from some other source. Several possible sources of oil leaks are listed, as follows:*

a. The oil plug in the rear of the cylinder block, which seals the rear of the main oil gallery. This plug is covered by the transmission adapter plate.

b. Oil leaking past the setscrews securing the bottom oil seal retainer to the oil pan seal housing. Special sealing washers are used with these setscrews.

c. The half-moon gasket around the outside of the oil pan seal housing; this gasket is of the correct length as supplied and should not be cut.

d. The gasket between the bottom oil seal retainer and the oil pan seal housing, or the gasket between the upper retainer and the cylinder block.

REMOVING THE OIL SEAL RETAINERS

To remove the rear crankshaft oil seal, proceed, as follows:

1. Separate engine from transmission housing.

2. Remove clutch assembly and flywheel.

3. Remove the adapter plate from the cylinder block and engine oil pan.

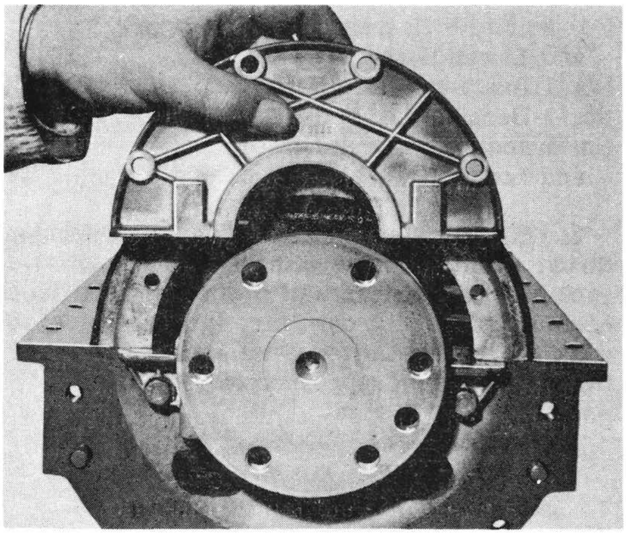

Fig. 45 – Removing or Installing the Oil Seal Retainers

4. Remove the two long setscrews which clamp the two oil seal retainers together.

5. Remove the setscrews from each half of the oil seal retainer and remove the retainers from the cylinder block and oil pan seal housing, as shown in Fig. 45.

REPLACING THE OIL SEALS

Thoroughly clean the oil seal retainers and inspect the jointing faces for flatness. True up the faces, if they are distorted.

NEW OIL SEALS SHOULD BE SOAKED IN CLEAN ENGINE OIL FOR ONE HOUR BEFORE THEY ARE INSTALLED.

To install new oil seals, place each half of the seal retainer (one at a time) in a vise, and proceed, as follows:

1. Press approximately one inch of the new asbestos seal into each end of the groove in the seal retainer, allowing the seal to project 0.010 -0.020 inch BEYOND both ends of the joint face. This amount of projection assures correct contact between the end faces of the seals when the retainer halves are installed around the crankshaft.

> *IMPORTANT: A projection exceeding that quoted above must be avoided, because excess may not settle in the retainer groove, and may be forced over the joint face as the retainer halves are pulled together. Thus, the retainers may be held slightly apart and cause an oil leak. Due to the interference between the seal and its groove, it is possible that the seal may not fully seat into the groove, giving the impression that it is too long. EACH SEAL IS OF THE CORRECT LENGTH AND MUST NOT BE TRIMMED AT ANY TIME.*

2. The middle of the oil seal will bulge out of the groove and must be pushed in with the fingers, working from the center, until well bedded in the groove. Use a round bar of metal to further bed in the strip by rolling and pressing, as shown in Fig. 46. MAKE SURE THAT THE SEAL EXTENDS 0.010-0.020 INCH BEYOND BOTH ENDS OF THE JOINT FACE, as shown in Fig. 46. Any gap at this joint, when the seals are installed, will allow oil to leak past the seal.

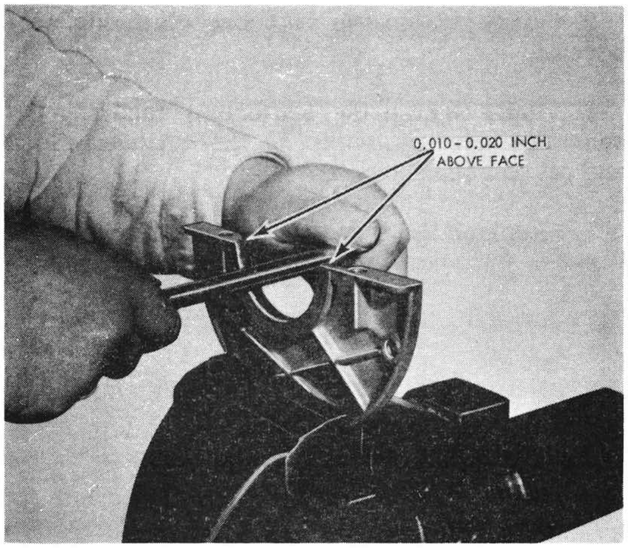

Fig. 46 – Bedding the New Oil Seal in Place

3. Repeat the above steps for the other half of the seal retainer.

INSTALLING THE OIL SEAL RETAINERS

1. Remove all of the old gasket material from the cylinder block and the oil pan seal housing and install new gaskets, using a suitable sealing compound.

2. Lightly coat the joint faces between the two retainers with a suitable sealing compound and coat the inside surface diameter of the oil seal WITH GRAPHITE GREASE.

3. Assemble the oil seal retainers around the crankshaft and loosely bolt them together.

4. Position the seal retainer assembly so that the holes align, then, LOOSELY bolt it to the cylinder block and oil pan seal housing, using the special washers.

> *NOTE: Use the shake-proof washers on the upper retainer and the aluminum sealing washers on the lower retainer.*

5. Fully tighten the two long clamping setscrews.

6. Fully tighten the setscrews securing the seal retainer assembly to the cylinder block and oil pan seal housing.

7. Replace the transmission adapter plate on the dowels at the rear of cylinder block and secure it in position.

8. Install the flywheel with the unevenly spaced holes in the flywheel and crankshaft in alignment. Tighten the flywheel setscrews to 75-ft.-lbs. torque and lock them, then, check the flywheel runout and complete reassembly.

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DUAL CLUTCH

35, 50 AND 65 MF & TO TRACTORS

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The Dual Clutch consists of a forward (primary) pressure plate and dry cushioned disc which is attached to the transmission input shaft, and a rearward (secondary) pressure plate and dry disc which is attached to the hydraulic pump and power take-off input shaft. The primary pressure plate is spring-loaded by twelve silicon-chrome alloy coil springs located between the clutch cover and the primary pressure plate. The secondary pressure plate is spring-loaded by an annular Belleville type spring located between the clutch cover and the secondary pressure plate or false flywheel ring.

The false flywheel ring is interposed between and integrated with the primary and secondary clutch sub-assemblies, and is secured to the flywheel by the same cap screws that attach the clutch cover. In operation, the clutch springs exert pressure against the clutch pressure plates, this in turn transmits the pressure through the discs to the false flywheel ring for the secondary clutch and to the engine flywheel for the primary clutch, thus establishing a firm frictional contact between the respective discs and flywheel faces.

Depressing the clutch pedal through the 1st stage moves the clutch release fork, which in turn contacts the clutch release bearing, moving it forward on the retainer and bringing it in contact with the clutch release fingers. The bearing depresses the fingers which in turn causes the primary pressure plate to retract from the disc and release the pressure on it. This interrupts the power flow to the transmission. Depressing the clutch pedal further through the 2nd stage (noticeable by an increased resistance to overcome) causes the same release fingers to move the primary pressure plate to a point where it contacts and causes the secondary pressure plate to retract from its respective disc, thus releasing the frictional contact between the disc and the false flywheel ring face. This interrupts the power flow to the hydraulic pump and power take-off input shaft.

The combination coil and Belleville spring dual clutch has been used in all 35 (MF & TO) tractors since Tractor Serial Number 177395, MF 50 Tractors since Tractor Serial Number 515395 and all models of the MF 65 Tractor.

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SERVICING THE CLUTCH ASSEMBLY

35, 50 and 65 CLUTCH ASSEMBLY DIFFERENCES

There are five parts in the 184 541 M91 clutch assembly (used in the 35 and 50 (MF & TO) tractors) which are changed in the 184 543 M91 clutch assembly (used in the MF 65 tractors). These changes are not all evident, therefore, use care when ordering parts.

NOTE: Be sure to use the correct parts whenever servicing the clutch assembly. This clutch may be used only with the ventilated type flywheel.

ADJUSTING THE CLUTCH

ADJUSTING THE RELEASE LEVER HEIGHT

Split the tractor between the engine and transmission if not previously done. When the clutch assembly has been properly attached to the flywheel, with a NEW primary disc in place, the clutch release lever height should be checked using the special gauge (No. 3, Fig. 1). The release lever height is measured from the machined surface of the clutch cover to the adjusting screw on the release levers as illustrated in Fig. 2. Loosen the lock nut and turn the adjusting screw in (or out) as required to obtain the proper height. Tighten the lock nut securely and recheck the adjustment.

NOTE: It is very important that the clutch release levers be adjusted with a NEW primary disc installed. If it is desired to reinstall a partially worn disc, the clutch should first be installed with a new disc in place and the adjustments made. Then remove the clutch assembly and install the partially worn disc without altering the adjustments.

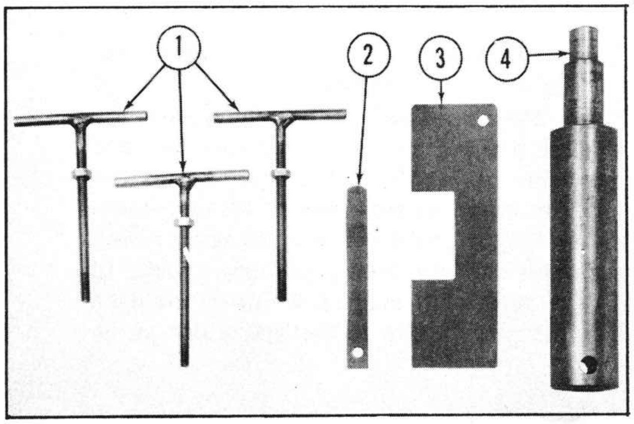

Fig. 1 Special Tools
1. "T" Bolts
2. 0.090 Inch Feeler Gauge
3. Clutch Finger Height Adjusting Tool
4. Clutch Disc Aligning Tool

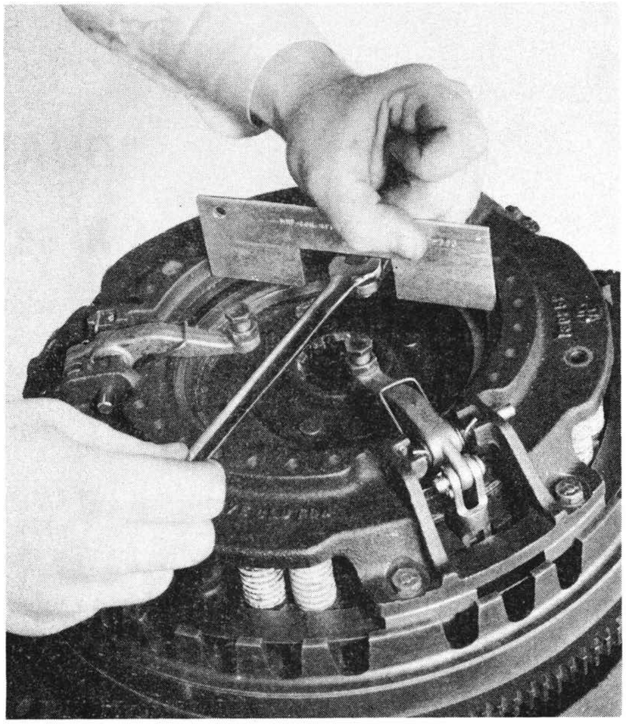

Fig. 2 Adjusting Clutch Finger Height

ADJUSTING THE SECONDARY PRESSURE PLATE CLEARANCE

The proper clearance between the adjusting cap screws and the secondary pressure plate is 0.090 ± 0.002 inch. Using the special 0.090 inch feeler gauge (No. 2, Fig. 1), the adjustment is made as illustrated in Fig. 3. Loosen the lock nut on the adjusting cap screw, turn the cap screw in (or out) until the 0.090 inch feeler gauge can be inserted between the cap screw head and the secondary pressure plate. Hold the cap screw and tighten the lock nut to lock the adjusting cap screw. Recheck the clearance. Be sure the clearance is the same for all three of the adjusting screws.

NOTE: If a partially worn, but still serviceable secondary disc is to be used in the clutch, the clutch should be adjusted to this partially worn secondary disc. It should be kept in mind, however, that the clutch release lever height should always be adjusted with a NEW primary disc installed.

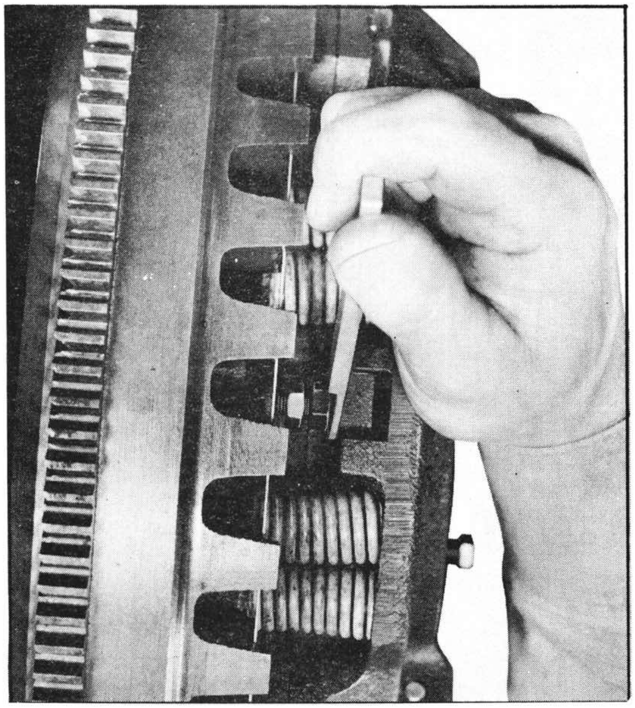

Fig. 3 Adjusting Secondary Pressure Plate Clearance

This adjustment can be made through the inspection cover on the bottom of the clutch housing if absolutely necessary.

REMOVING THE CLUTCH ASSEMBLY FROM THE FLYWHEEL

1. Split the tractor between the engine and the transmission.

2. Install the 1/4" x 6" special "T" bolts with nuts and washers through the holes in the clutch cover to hold the assembly together while removing it from the flywheel.

> *NOTE: Tighten the "T" bolt nuts evenly until the release levers are depressed completely. (The coil springs will be compressed to their solid height.) See Fig. 4.*

3. Reference mark the clutch assembly and flywheel and remove the cap screws which secure the cover assembly to the engine flywheel.

4. Remove the clutch assembly and primary friction disc from the flywheel using care not to damage or distort the air ring between the clutch assembly and the ventilated flywheel.

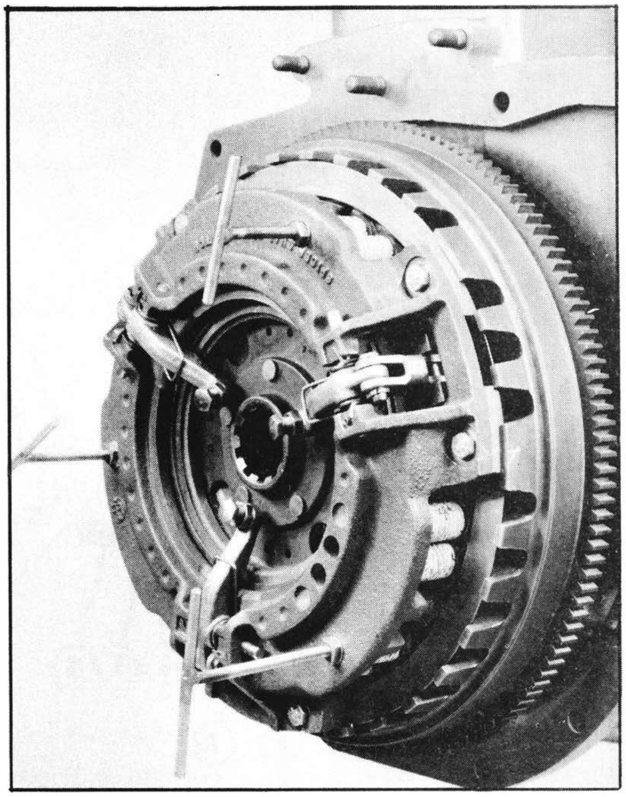

Fig. 4 Installing the "T" Bolts

DISASSEMBLING THE DUAL CLUTCH ASSEMBLY

1. Punch mark the engine flywheel, the clutch cover, 9 inch pressure plate, the flywheel plate

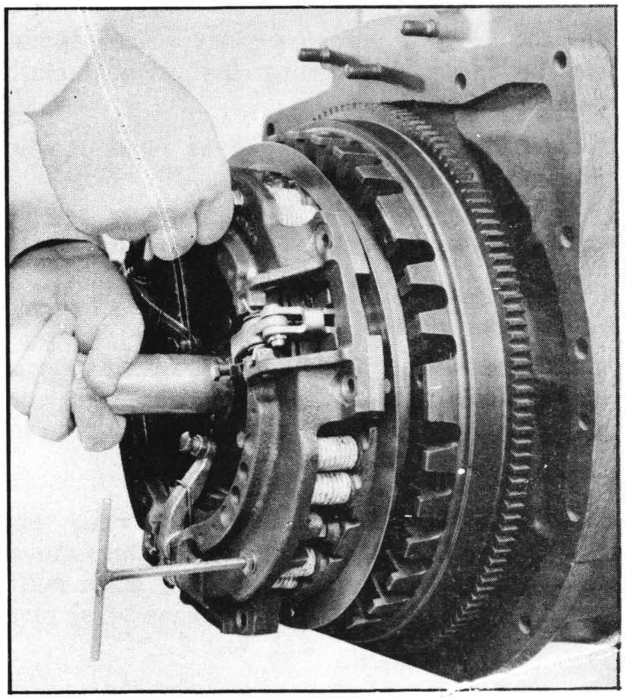

Fig. 5 Removing the Clutch

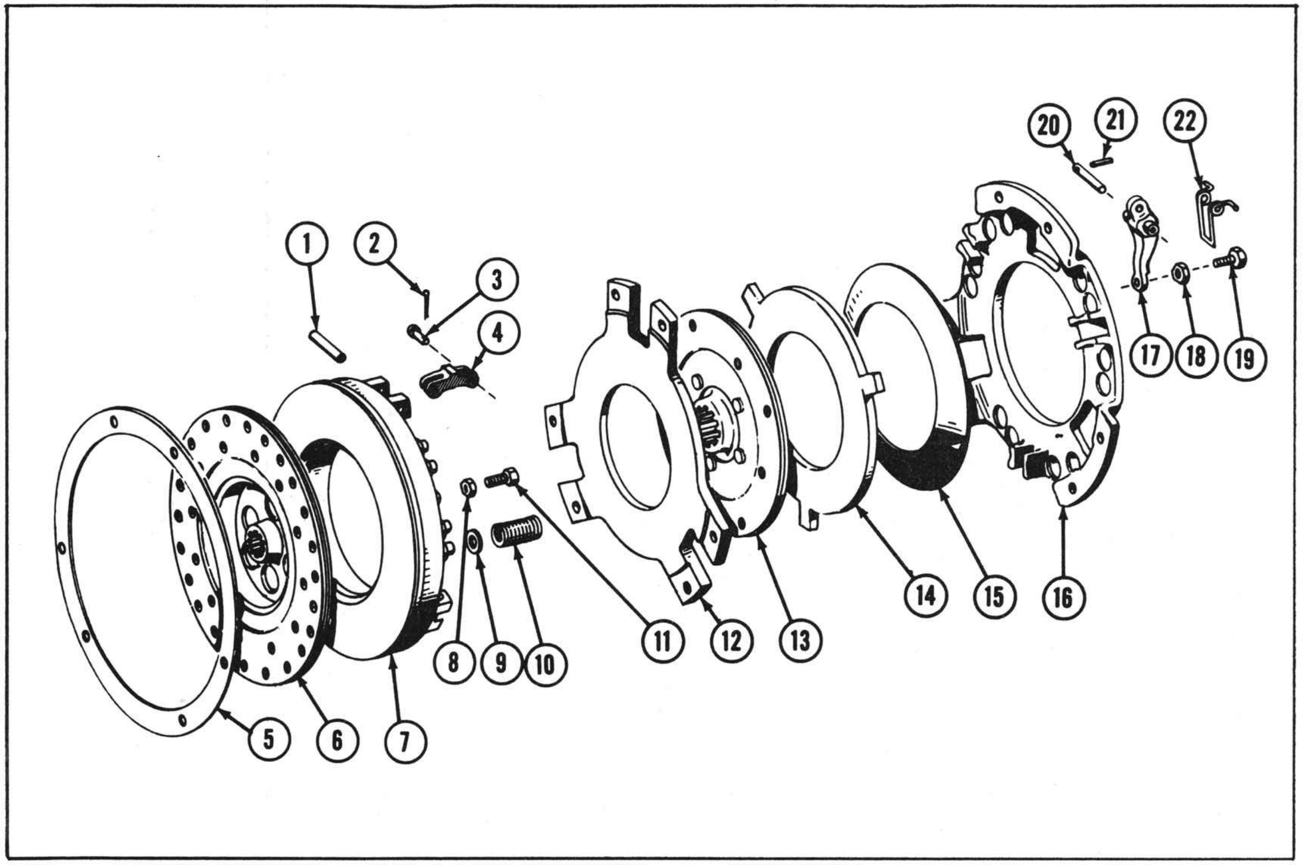

Fig. 6 Clutch Assembly Nomenclature

1. Lower Pivot Pin
2. Cotter Pin
3. Link Pin
4. Link
5. Air Ring
6. 11" Friction Disc
7. 11" Pressure Plate
8. Adjusting Screw Lock Nut
9. Insulating Washer
10. Coil Spring
11. Adjusting Screw
12. False Flywheel
13. 9" Friction Disc
14. 9" Pressure Plate
15. Belleville Spring
16. Clutch Cover
17. Release Lever
18. Adjusting Screw Lock Nut
19. Adjusting Screw
20. Upper Pivot Pin
21. Retainer Pin
22. Torsion Spring

and the 11 inch pressure plate so reassembly can be made maintaining the original clutch balance. See Fig. 5.

NOTE: It is necessary to mark the cover in two places.

2. Unhook the release lever torsion spring ends (No. 22) from clutch cover (No. 16, Fig. 6) releasing the springs and lever arm preload.

3. Loosen the 0.090 inch adjustment cap screw lock nut (No. 8) and tighten the cap screws (No. 11, Fig. 6) until they bottom in the 11 in. pressure plate.

4. Back-off the "T" bolt nuts evenly until it is possible to drive the upper release lever pivot pin retainer pins (No. 21) down sufficiently to remove the upper release lever pivot pin (No. 20, Fig. 6). See Fig. 7.

NOTE: Do not attempt to drive the retainer pin completely out of the cover assembly. The pins can be removed very easily once the cover has been removed from the clutch assembly.

5. Remove the upper release lever pivot pins and torsion springs. See Fig. 8.

6. Loosen the nuts on the "T" bolts evenly until the coil springs (No. 10, Fig. 6) are fully extended and the cover is free.

7. Remove the "T" bolts.

8. Lift off the clutch cover, Belleville pressure plate spring (No. 15), the 9-in. pressure plate (No. 14), the 9-in. friction disc (No. 13) and flywheel plate (No. 12, Fig. 6).

9. Remove the coil pressure springs and pressure spring insulating washers (No. 9) from the 11-in. pressure plate and remove the lower release pivot pins (No. 1, Fig. 6) from the pressure plate. See Fig. 9.

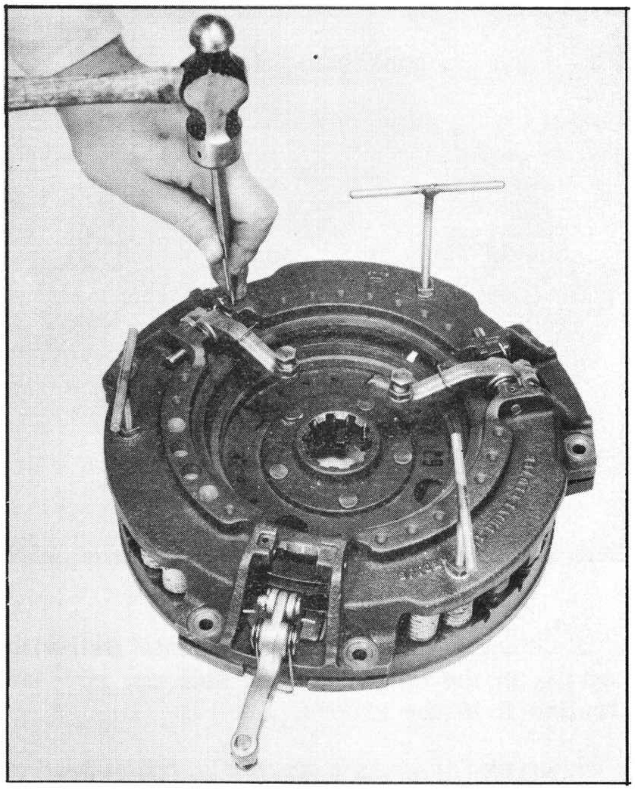

Fig. 7 Removing Retainer Pins

10. Turn the cover assembly over and drive out the upper release lever pivot pin retainer pins. See Fig. 10.

This completes the clutch disassembly except for the 0.090 inch adjustment pusher cap screws which may be removed at this time if necessary.

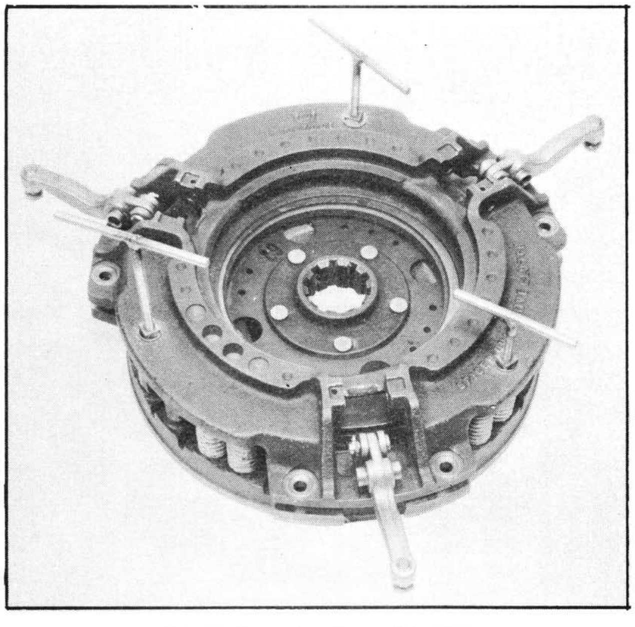

Fig. 8 Removing Upper Pivot Pins

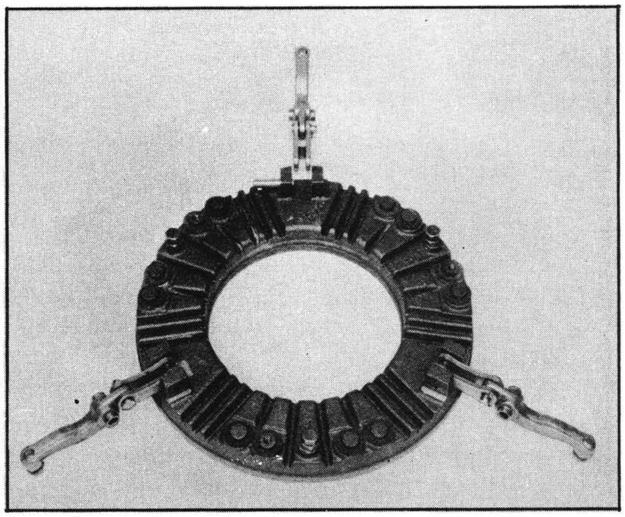

Fig. 9 Removing Lower Pivot Pins

It is recommended that the pilot bearing and release bearing be replaced each time one or more clutch friction discs are installed in the clutch assembly.

INSPECTING THE CLUTCH ASSEMBLY

1. Test the coil springs and replace those not meeting minimum specifications.

Replace insulating washers each time a spring is replaced and whenever the washers show signs of deterioration or excessive heat.

2. Replace the Belleville washers whenever there is evidence of excessive heat.

3. Inspect the upper and lower pivot pins and pin holes for wear and grooving.

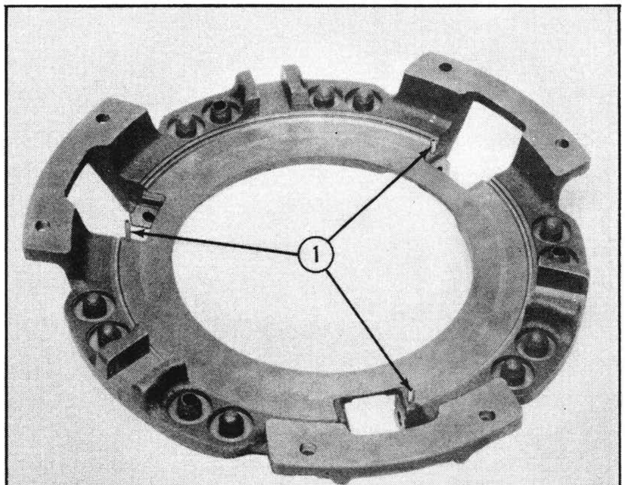

Fig. 10 Removing Retainer Pins
1. Retainer Pins

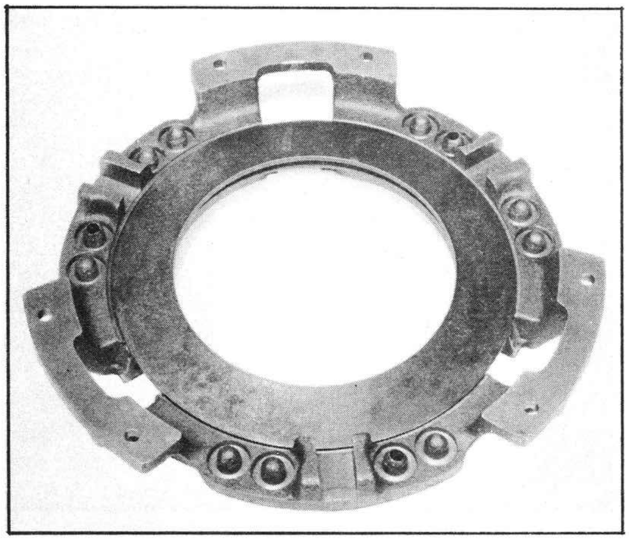

Fig. 11 Installing Belleville Spring

4. Check the release lever torsion springs for damage.

5. Examine clutch facings for damage, signs of overheating and excessive wear. Check for loose rivets and damaged driving splines. Replaces if necessary.

6. Inspect the clutch cover for damage.

ASSEMBLING THE DUAL CLUTCH ASSEMBLY

1. Place the clutch cover upside down on a bench.

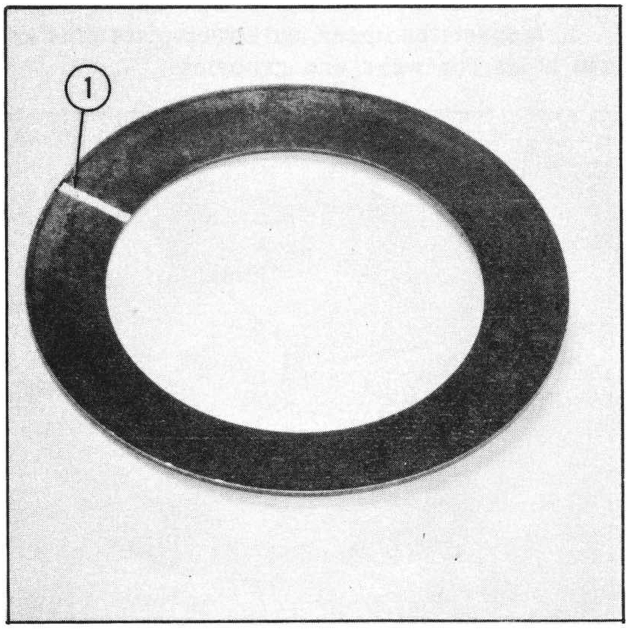

Fig. 12 Belleville Spring
1. Paint Mark

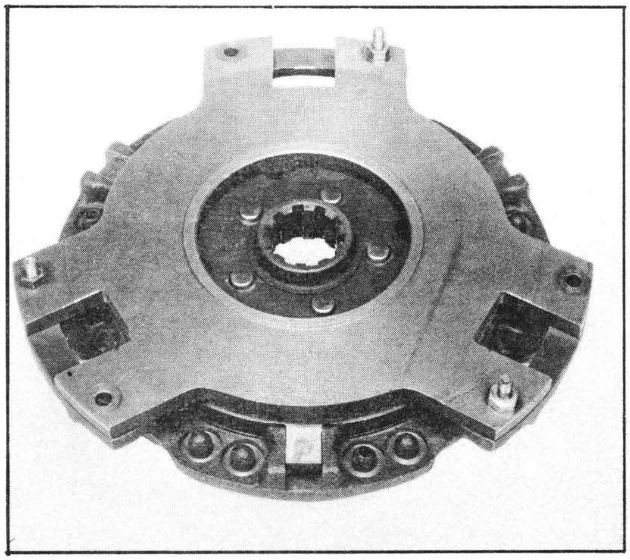

Fig. 13 Assembling Secondary Clutch

2. Place the 9-in. pressure plate Belleville spring in the cover, convex side up, and centralize it in the groove. See Fig. 11.

> *NOTE: For 35 & 50 (MF & TO) Tractors use a red paint marked Belleville spring. For MF 65 tractors use a blue paint marked Belleville spring. See Fig. 12.*

3. Place the 9-in. pressure plate on the Belleville spring with the shoulder side against the spring. Align the punch marks.

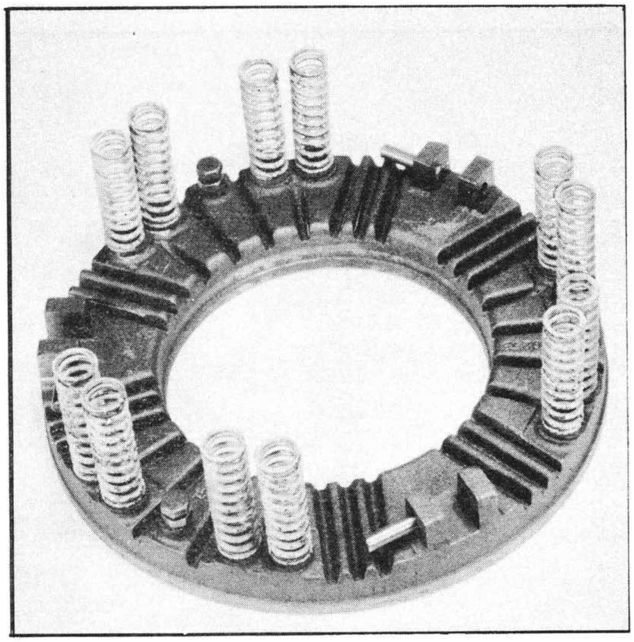

Fig. 14 Build-Up of Primary Pressure Plate

4. Place the 9-in. friction disc assembly, centered, on the pressure plate with the hub side away from the flywheel.

5. Place the flywheel plate on the friction disc with the smooth side toward the disc. Align the punch marks.

6. Bolt the cover and flywheel plate together tightly with three 5/16'' x 1-1/2'' bolts through the cover to flywheel mounting holes. See Fig. 13.

7. Place the 11-in. pressure plate, face down, on a bench and install the pressure spring insulating washers and pressure springs over the raised buttons on the pressure plate. Install the adjusting cap screws and lock nuts, bottoming the cap screws in the 11-in. pressure plate. See Fig. 14.

8. Add a light coat of "Lubriplate (Grade 70)" to the lower release pivot pins and insert them into one side of the tabs.

9. Place the cover assembly on the pressure springs, being certain the springs are seated on the raised buttons of the cover assembly and that the marks are aligned.

10. Insert the "T" bolts through the cover assembly and bottom them in the 11-in. pressure plate. See Fig. 15.

11. Tighten the "T" bolt nuts evenly until the flywheel plate just clears the lower release pivot pins. Install the release levers and lower pivot pins. See Fig. 16.

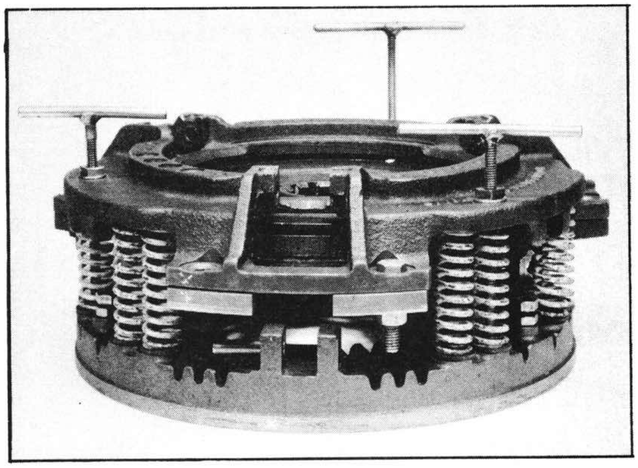

Fig. 15 Assembling Primary and Secondary Clutch

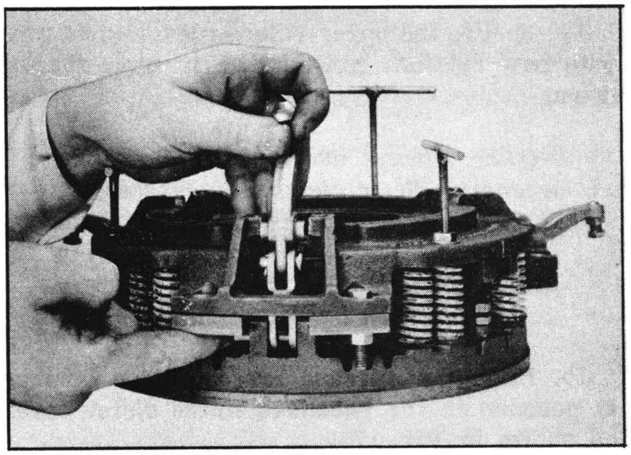

Fig. 16 Installing Lower Pivot Pins

NOTE: Use this method of installation of the release levers because the release levers may bind between the levers and the cover assembly, when tightening the "T" bolt nuts, causing damage to the cover assembly.

12. With the release levers in position, tighten the "T" bolt nuts evenly until the upper release lever pivot pins can be inserted easily.

NOTE: Be sure when tightening the "T" bolt nuts that no binding of the release levers occurs within the cover.

13. Install the upper release lever pivot pins and springs. See Fig. 17.

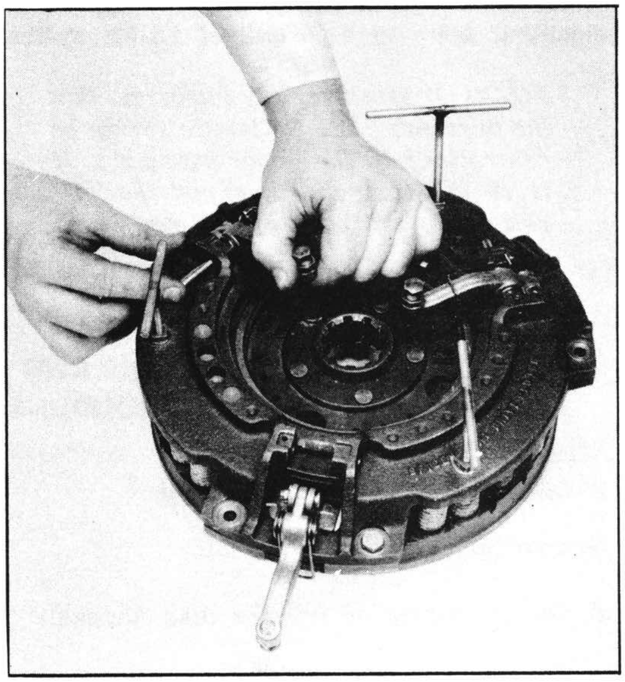

Fig. 17 Installing Upper Pivot Pins

14. Secure the upper release lever pivot pins with new retainer pins driven in from the top down.

> *NOTE: Always use new retainer pins whenever the clutch is disassembled. It is also recommended that the hole in the clutch cover, through which the pin is inserted, be distorted slightly with a punch on the top of the cover.*

15. Hook the release lever torsion springs in position in the recesses in the clutch cover as shown in Fig. 17.

16. Tighten the "T" bolt nuts evenly until the release levers are completely depressed. (The coil springs will be compressed to their solid height.)

17. Remove the clutch cover to flywheel plate securing bolts from the mounting holes. The clutch assembly is now ready for installation.

INSTALLING THE CLUTCH ASSEMBLY

1. Place the ventilated flywheel air ring in position on the flywheel.

2. With the clutch pilot tool (No. 4, Fig. 1), inserted through the 9-in. driven and 11-in. clutch discs, insert the clutch assembly into the ventilated flywheel and fasten it to the flywheel with the mounting bolts. Tighten the mounting bolts to a torque of 28-33 ft.-lbs.

> *NOTE: It is extremely important that the pressure plate Belleville spring be centralized in the cover assembly. If it is not centralized, adjust the "T" bolt nuts, until the spring can be re-centered.*

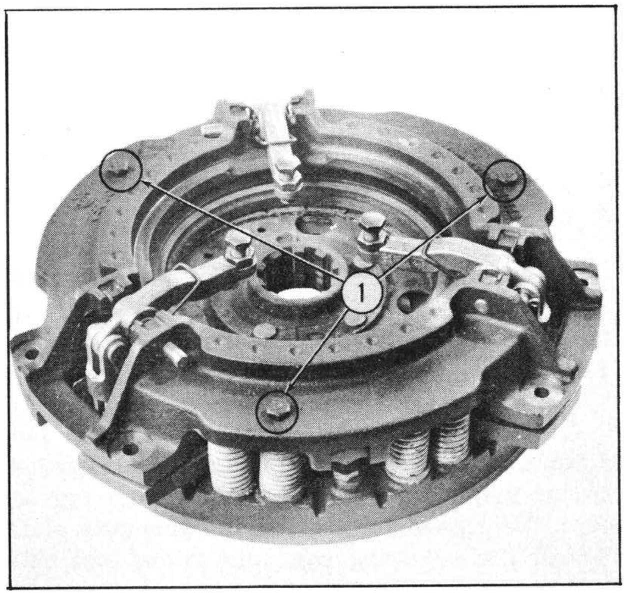

Fig. 18 Assembly Hold-Down Bolts
1. Hold-Down Bolts

3. Remove the clutch pilot tool.

4. Remove the "T" bolts from the clutch cover assembly and adjust the clutch release lever height and secondary pressure plate clearance. See page 2.

> *NOTE: Should it become necessary to install an entirely new clutch cover assembly, the assembly received from the repair parts will have three (3) cap screws securing the assembly as shown in Fig. 18. These cap screws MUST be removed once the assembly is installed to the engine flywheel.*

5. Reassemble the tractor.

> *NOTE: Place a light coat of "Lubriplate (Grade 70)" on the PTO and Main drive shaft before reassembly.*

COMBINATION COIL AND BELLEVILLE SPRING DUAL CLUTCH TROUBLE-SHOOTING CHART

PROBLEM — Clutch drag or spin

POSSIBLE CAUSE	CORRECTION
a) Oil or grease on friction disc facings.	Install new friction disc.
b) Improper pedal adjustment not allowing free movement to release bearing.	Correct pedal adjustment.

POSSIBLE CAUSE	CORRECTION
c) Damaged pressure plate or clutch cover.	Replace defective part.
d) Friction disc hub binding on splined drive pinion shaft.	Clean up splines and smear with small quantity of "Lubriplate (Grade 70)".
e) Distorted friction disc.	Install new friction disc.
f) Broken facings or friction disc.	Install new friction disc.
g) Dirt or foreign matter in the clutch.	Remove clutch from flywheel and clean with dry rag. See that all working parts are free.

PROBLEM — Clutch slip

POSSIBLE CAUSE	CORRECTION
a) Oil or grease on friction disc facings.	Install new friction disc.
b) Weak coil or Belleville spring. If excessive slip is allowed to occur, the heat generated will soften the springs and aggravate the trouble.	Install a new set of thrust springs (single clutch), or a new Belleville spring (dual clutch).
c) Binding of clutch pedal mechanism.	Free bearings. (NOTE: The clutch shaft bearings in the transmission case are self-lubricating. Oil or grease should ON NO ACCOUNT be applied.)
d) Improper pedal adjustment preventing full engagement.	Correct pedal adjustment.

PROBLEM — Clutch grabbing

POSSIBLE CAUSE	CORRECTION
a) Oil on friction disc.	Install new friction disc.
b) Binding of clutch pedal mechanism.	Free bearings. (NOTE: The clutch shaft bearings in the transmission case are self-lubricating. Oil or grease should ON NO ACCOUNT be applied.)
c) Worn out friction disc facings.	Install new friction disc.

PROBLEM — Clutch chatter

POSSIBLE CAUSE	CORRECTION
a) Oil, grease or foreign matter on friction disc facings.	Install new friction disc.
b) Contact area friction facings not evenly distributed. NOTE: 100% contact will not occur until clutch has been in use for some time, but contact area should be evenly distributed round the facings.	Adjust release levers correctly, using gauge. If this does not cure the trouble, install new friction disc.
c) Buckled friction disc(s).	Install new friction disc.

PROBLEM — Clutch Rattle

POSSIBLE CAUSE	CORRECTION
a) Anti-rattle spring(s) broken. Damaged friction disc. Worn parts in release mechanism. Excessive backlash in transmission. Wear in transmission bearings.	Install new parts as necessary.

PROBLEM — Abnormal facing wear

POSSIBLE CAUSE	CORRECTION
a) Usually caused by riding the clutch and excessive slippage.	Instruct operator on proper operation.

PROBLEM — PTO stops when tractor is halted - (Dual Clutch)

POSSIBLE CAUSE	CORRECTION
a) Insufficient dual plate clearance.	Adjust clearance.

PROBLEM — PTO cannot be stopped - (Dual Clutch)

POSSIBLE CAUSE	CORRECTION
a) Excessive dual plate clearance.	Adjust clearance.

COMBINATION COIL AND BELLEVILLE SPRING DUAL CLUTCH SPECIFICATIONS

Item	MF(and TO)35 and 50	MF 65
Spring Color	Yellow	Lavender
Number of coils - Total	11-1/2	10
Number of coils - Active	9-1/2	8-7/64
Free Length	2-45/64 in.	2-21/64 in.
Length in use - Minimum	1-11/32 in.	1-11/32 in.
Solid Height - Maximum	1-9/32 in.	1-9/32 in.
Test Length	1-1/2 in.	1-1/2 in.
Test Load	80-88 lbs.	111-123 lbs.
Belleville Color Mark	Red	Blue

PART 3—DUAL BELLEVILLE SPRING CLUTCH

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Splitting Tractor	1
Disassembly of the Clutch Assembly	1
Reassembly of Clutch Assembly	2
Adjustments	3
Assembling Clutch Housing to Engine	3
Trouble Shooting	3

DESCRIPTION

The dual clutch consists of two dry-type clutch discs. One 11" primary disc driving the tractor power train, and one 9" disc driving the PTO shaft and the hydraulic pump. This clutch has two belleville-type springs washers, which exert pressure on the clutch disc. In order to remove the clutch, it will be necessary to split the tractor at clutch housing. To do so, proceed, as follows:

SPLITTING TRACTOR

1. Drain cooling system and, on 35 models, tip hood assembly forward and disconnect steering rods.

2. On 40 and 50 models, remove screws at rear of side panels to instrument panel and disconnect steering rod from pitman arm.

3. Shut off fuel; remove fuel line and bolts at rear of fuel tank. Block between fuel tank and valve cover.

4. Disconnect battery cables, wires and lines between engine and transmission.

5. Use suitable jack or hoist to support the engine and the transmission assembly.

6. Remove capscrews around the clutch housing and separate the two units.

DISASSEMBLY OF THE CLUTCH ASSEMBLY

Before disassembling the clutch assembly, punch-mark all parts to insure balancing when unit is reassembled. Place clutch assembly in a press or suitable clamps, and compress until the release levers are free. Loosen the lock nuts and turn release lever adjusting screws, No. 4, Fig. 1, completely out.

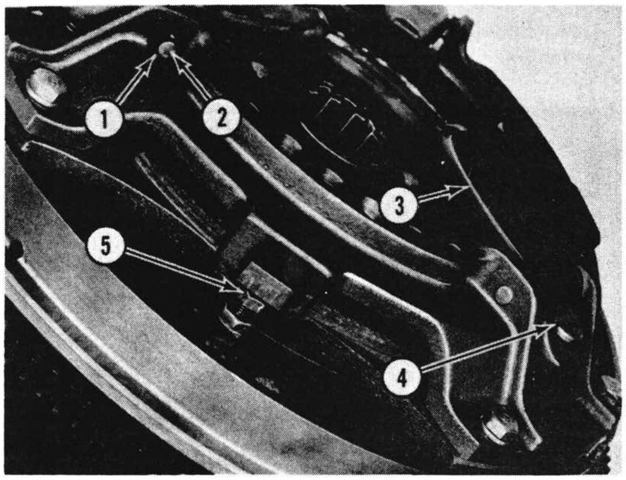

Fig. 1 – Clutch Assembly Attached to Flywheel

1. Groove Pin
2. Pivot Pin
3. Release Lever
4. Lever Adjusting Screw
5. Secondary Clutch Adjusting Screw

Remove press and lift assembly apart. Drive out roll pins, No. 1, Fig. 1, remove pin, No. 2, and release lever, No. 3.

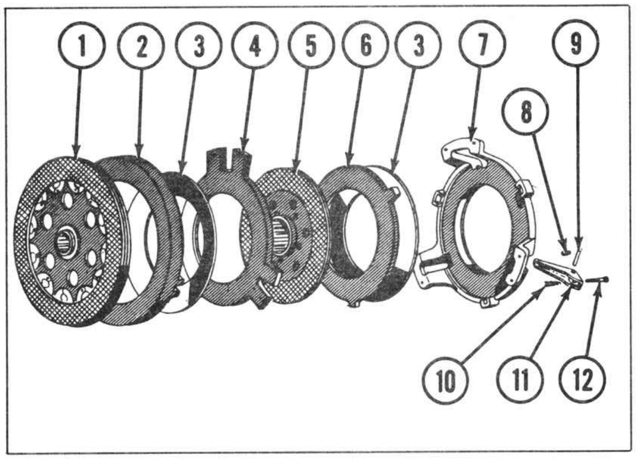

Fig. 2 – Clutch Assembly Nomenclature

1. 11" Friction Disc
2. 11" Pressure Plate
3. Belleville Spring
4. False Flywheel
5. 9" Friction Disc
6. 9" Pressure Plate
7. Clutch Cover
8. Roll Pin
9. Pivot Pin
10. Tension Spring
11. Release Lever
12. Lever Adjusting Screw

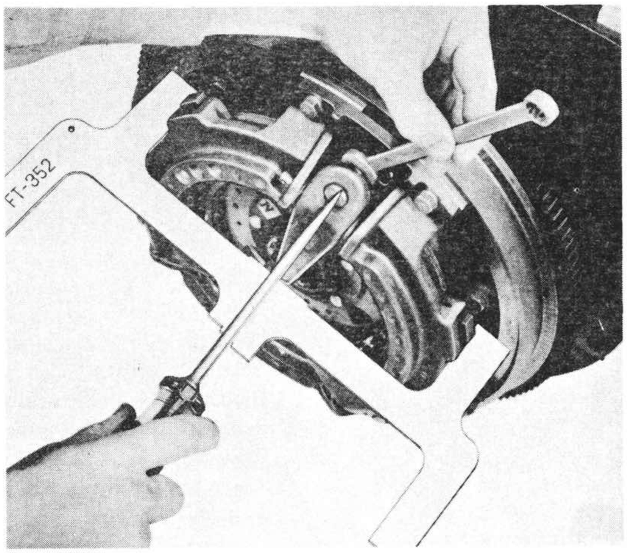

Fig. 4 – Adjusting Release Fingers

REASSEMBLY OF CLUTCH ASSEMBLY

Fig. 2 shows sequence of parts. Place primary pressure plate on bench with machined surface down. Examine the two belleville spring washers. If one is thicker than the other, place the thick one next to the primary pressure plate with the convex side up. If the washers are the same thickness, use either one. Place secondary pressure plate with flat side up. Align the secondary clutch disc on the pressure plate, making sure the long side of the hub is up. Install the outer pressure plate with the flat side down, making sure all punch marks are in register. Install the remaining belleville washer with the concave side up. Place the clutch cover in position and, using a press or clamps to hold in place, start the adjusting screws into place and turn in as far as possible with a screwdriver. With the clutch aligning tool FT 355, install the clutch assembly to the flywheel, with the primary disc hub turned toward the pressure plate, as shown in Fig. 3.

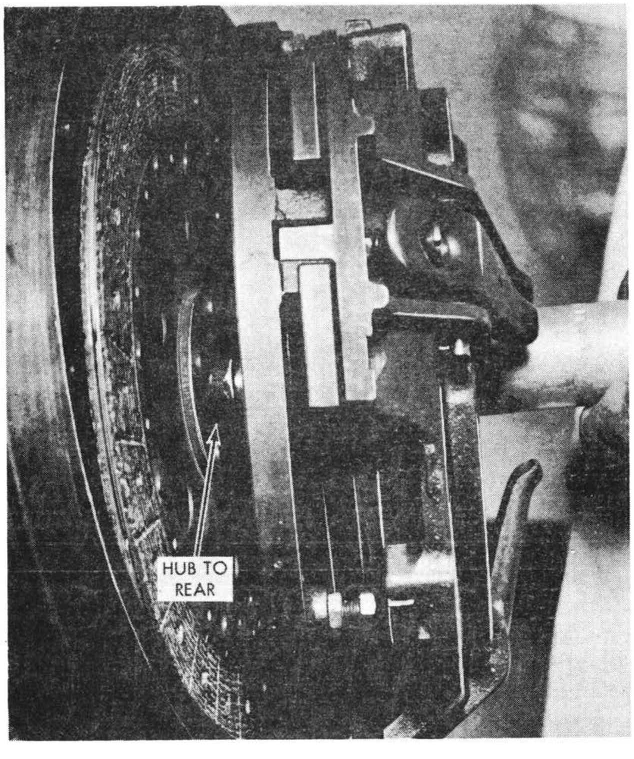

Fig. 3 – Installing Clutch Assembly

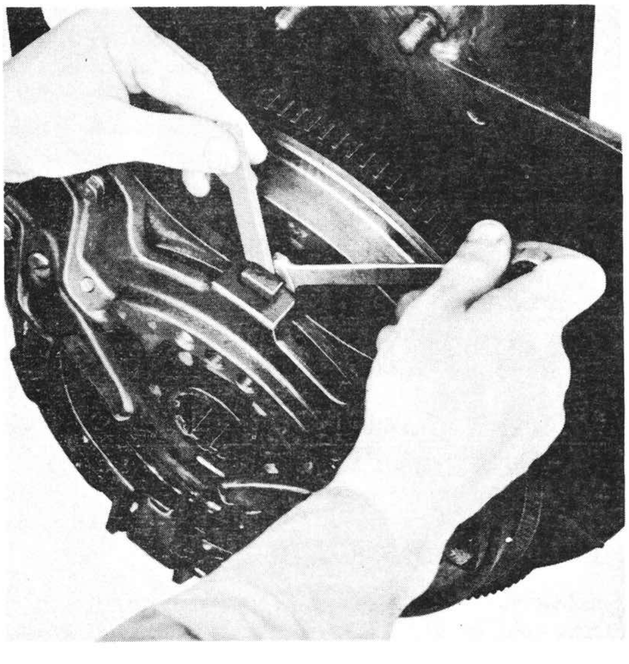

Fig. 5 – Adjusting Secondary Clutch Clearance

ADJUSTMENTS

With the use of the gauge FT 352, adjust clutch release finger by turning in or out on adjusting screws to obtain a zero clearance between gauge and release fingers. See Fig. 4. Tighten lock nut. Adjust clearance of secondary clutch to .090", using special tool FT 354, see Fig. 5.

> *NOTE: These adjustments must be made with a new clutch disc.*

Adjustments to compensate for lining wear is accomplished by adjusting clutch pedal, not by adjusting the release levers on the clutch cover assembly.

ASSEMBLING CLUTCH HOUSING TO ENGINE

After the clutch has been installed and adjusted, the clutch housing and engine can be attached together by reversing the previous procedure in chapter (splitting tractor). To adjust clutch pedal free travel, loosen bolt on clutch pedal to clutch shaft. Insert punch in clutch shaft hole and rotate shaft, and throw out bearing against clutch fingers. Set clutch pedal to obtain a 3/8" clearance between pedal and stop. See Fig. 6. Tighten pedal to shaft bolt.

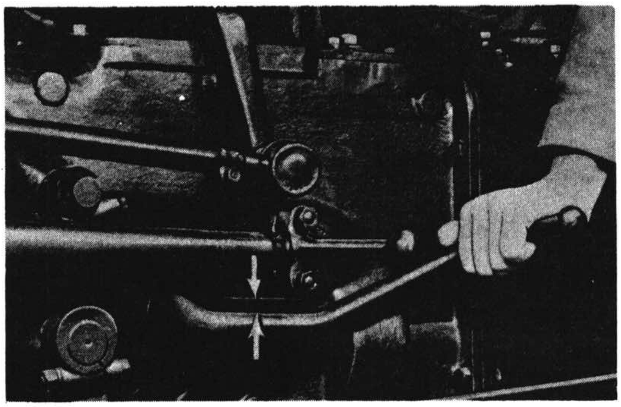

Fig. 6 – Clutch Pedal Adjustment

Listed below are special tools required to service the clutch:

1. OTC - FT 352 - Clutch finger gauge.
2. FT 354 - Clutch capscrew feeler gauge.
3. FT 355 - Clutch aligning tool.

TROUBLE-SHOOTING—DUAL CLUTCH WITH TWO BELLEVILLE SPRING WASHERS

PROBLEM

1. Clutch dragging.

Possible Cause	***Correction***
(a) Oil or grease on friction disc.	(a) Install new friction disc.
(b) Improper pedal adjustment.	(b) Adjust pedal free travel clearance.
(c) Damaged pressure plate or clutch cover.	(c) Replace defective parts.
(d) Friction disc binding on splines.	(d) Clean splines and lubricate.
(e) Distorted or broken friction disc.	(e) Replace friction disc.
(f) Dirt or foreign matter in clutch.	(f) Remove, clean and lubricate all moving parts.

PROBLEM

2. Clutch slipping.

Possible Cause	**Correction**
(a) Oil on friction disc or worn lining.	(a) Install new friction disc.
(b) Weak belleville spring washers. If excessive slipping is allowed to occur, heating will tend to weaken these washers.	(b) Install new belleville spring washers.
(c) Bind of clutch pedal mechanism.	(c) Free clutch linkage and bearings. *(NOTE: Clutch shaft bearings in transmission housing are self-lubricating and must not be lubricated.)*
(d) Improper clutch pedal adjustment.	(d) Adjust clutch pedal free travel.

PROBLEM

3. Clutch grabbing.

Possible Cause	**Correction**
(a) Oil on friction disc.	(a) Install new disc and correct oil leak, if any.
(b) Binding of clutch pedal mechanism.	(b) Free clutch pedal mechanism.
(c) Worn friction disc.	(c) Replace friction disc.

PROBLEM

4. PTO will not stop when clutch is depressed.

Possible Cause	**Correction**
(a) Secondary disc sticking to pressure plate.	(a) Remove clutch assembly and free disc.
(b) Incorrect clearance between secondary adjusting screws and pressure plate.	(b) Adjust clearance to .090" on all three screws.

PART 7—CLUTCH LINKAGE AND RELEASE MECHANISM

MF 65 TRACTORS ALSO MF 50 TRACTORS AFTER SERIAL NO. 533 422

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Servicing the Clutch Release Mechanism 3
Inspecting the Clutch Release Mechanism 5
Assembling and Installing the Clutch
  Release Mechanism 5

DESCRIPTION

The MF 65 and 50 Tractors have two types of clutch linkage and release mechanism. The MF 65 Tractors, prior to Serial No. 692 932, have the type linkage shown in Fig. 1. For MF 65 Tractors, after Serial No. 692 932, also MF 50 Tractors after Serial No. 533 422, refer to Fig. 2. Before attempting any adjustment of clutch external linkage, note serial number of tractor. Refer to the appropriate heading for the particular type linkage to be adjusted.

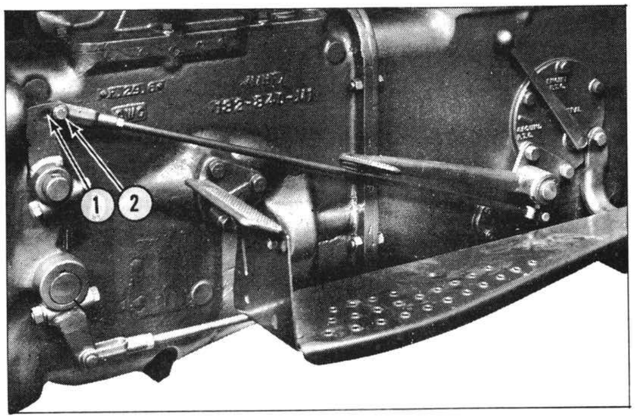

Fig. 1 – Clutch External Linkage Early MF 65

1. Normal Operating Position 2. Modified Operating Position

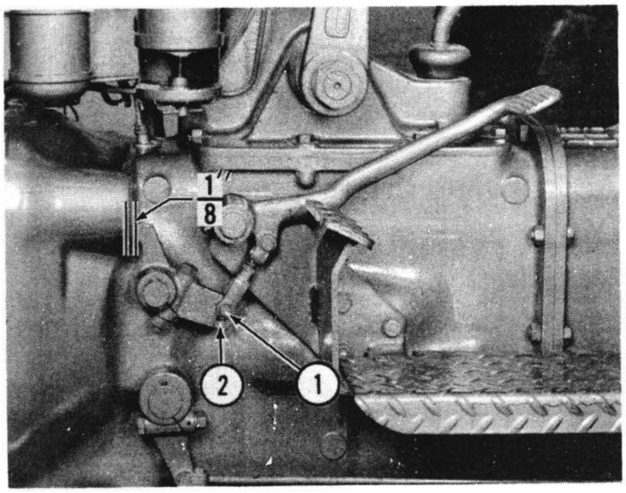

Fig. 2 – Clutch External Linkage Late MF 65 and Late MF 50

1. Normal Operating Position 2. Modified Operating Position

CHECKING THE CLUTCH PEDAL FREE-PLAY

To make sure of full clutch engagement, and to protect the clutch release bearing, it is important that adequate clearance exists between the clutch release fingers and the release bearing. This clearance is evident externally as clutch pedal free-play.

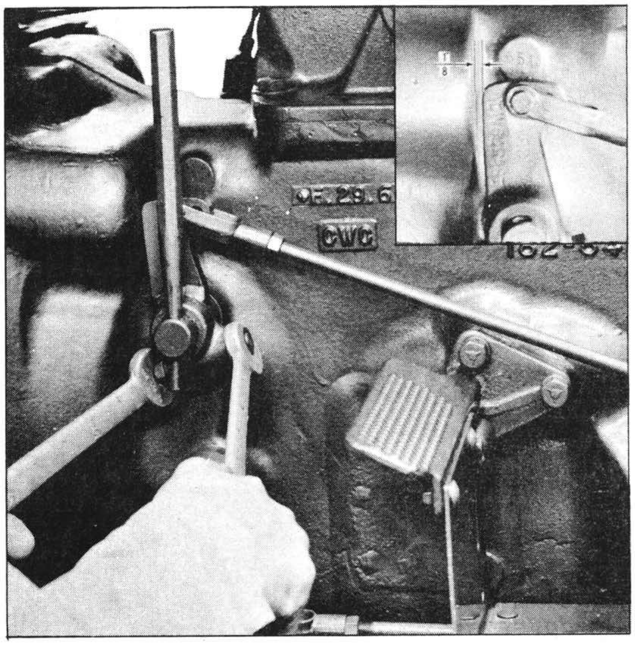

Fig. 3 – Adjusting Pedal Free Play

Depress the clutch pedal with the hand until the engagement of the release bearing with the release finger is felt. The forward edge of the clutch release shaft arm should be 1/8 inch from the transmission case. Fig. 3 shows this clearance, which is the same on both models.

ADJUSTING CLUTCH PEDAL FREE-PLAY

Refer to Fig. 3, which is similar on both models, with the exception of the external linkage.

1. Loosen the clamp bolt in the release shaft arm and place a punch through the hole provided in the end of the clutch release shaft.

2. Rotate the shaft clockwise until release bearing contact clutch fingers.

3. Move the release shaft arm 1/8 inch away from transmission case.

4. Tighten the retaining bolt securely and recheck this clearance.

ADJUSTING CLUTCH LINKAGE

The clutch pedal travel must be correct to ensure proper clutch disengagement. To check and adjust the clutch linkage, proceed, as follows:

1. Remove PTO cap and shift PTO lever into engine PTO.

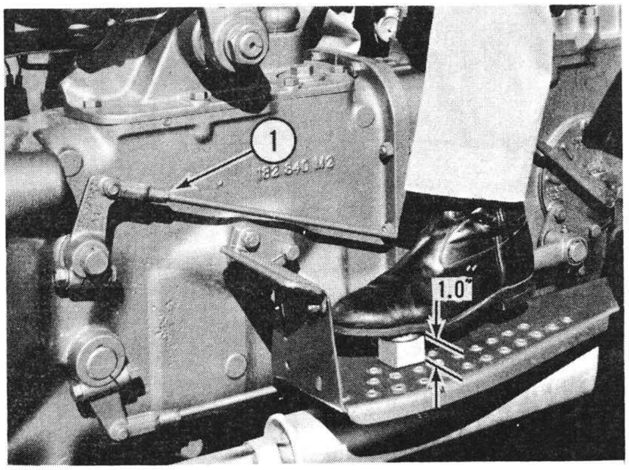

Fig. 4 – Adjusting Clutch Linkage
1. Pull-Rod Clevis

2. Place a 1-inch block under the clutch pedal, as shown in Fig. 4. On late model, the release linkage is different but the same procedure can be followed.

3. Start the engine and run at idle speed.

4. Slowly depress the clutch pedal and note the action of the PTO shaft.

5. If the PTO shaft on early models continues to rotate after the pedal reaches the block, remove the clutch pull rod clevis pin and shorten the rod by rotating the clevis (No. 11, Fig. 5) and recheck.

6. If the PTO shaft stops before the clutch pedal reaches the block, lengthen the rod and recheck.

7. When the correct adjustment is obtained, install the clevis pin and lock the clevis lock

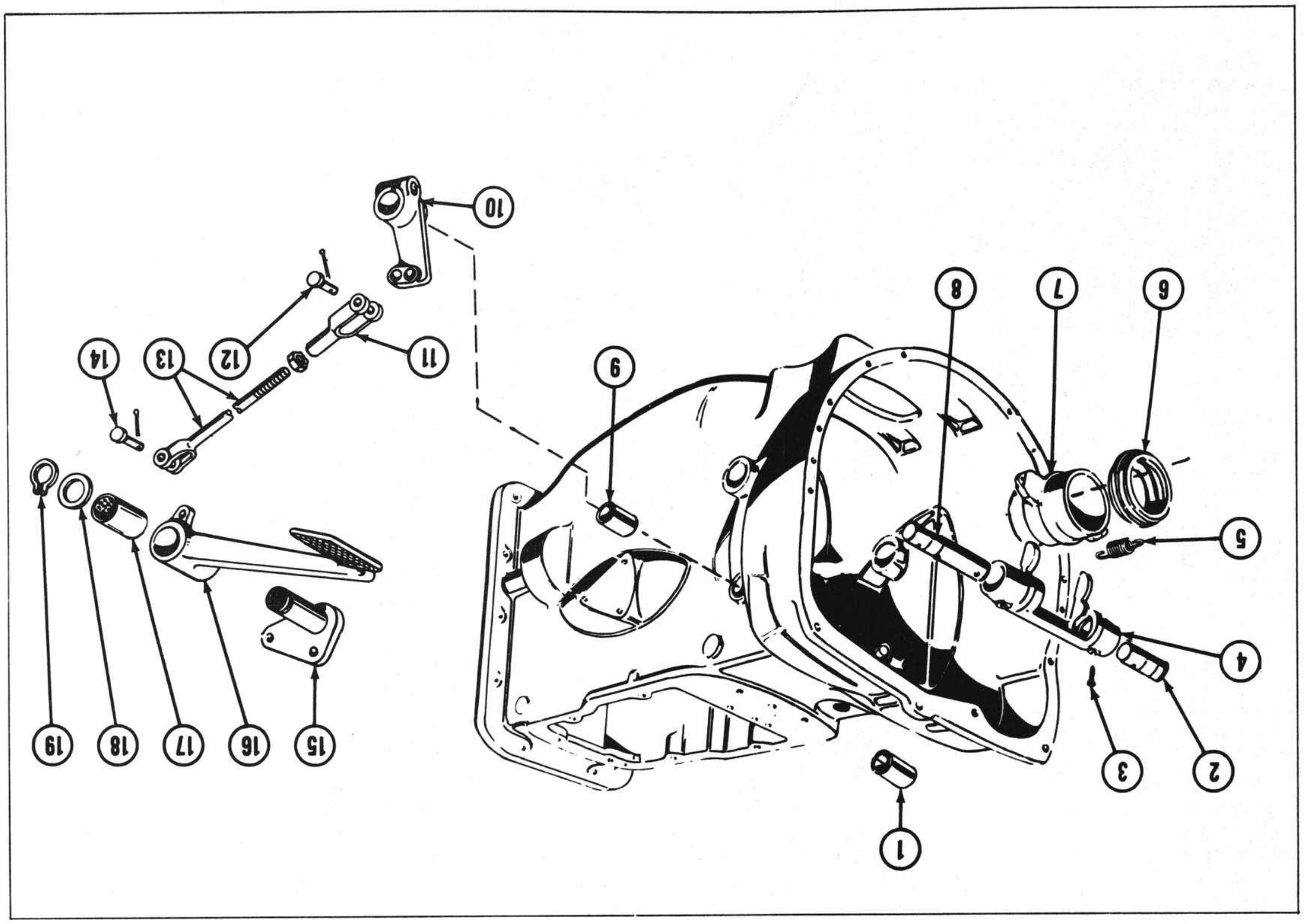

Fig. 5 – Release Mechanism Nomenclature Early MF 65

1. Release Shaft Bushing
2. R.H. Release Shaft
3. Set Screw
4. Release Bearing Fork
5. Release Bearing Return Spring
6. Release Bearing
7. Release Bearing Carrier
8. L.H. Release Carrier
9. Release Shaft Bushing
10. Release Shaft Arm
11. Pull-Rod Clevis
12. Clevis Pin
13. Pull Rod
14. Clevis Pin
15. Pedal Pivot Pin
16. Clutch Pedal
17. Pedal Bushing
18. Pivot Pin Washer
19. Snap Ring

nut. On late model tractors, the adjustment of the clutch rod and clevis would be in the reverse of items 5 and 6 because the rod is pushed, rather than being pulled, by the clutch pedal.

CLUTCH LINKAGE SELECTIONS

The dual clutch linkage is designed so that it can be changed from its normal clutch operation to a constant-running hydraulic pump. On MF 65 Tractors, prior to Serial No. 692 932, the clutch rod clevis pin can be placed in the rear hole (No. 2, Fig. 1) of the clutch release shaft arm. In this position, only, the primary clutch can be disengaged, and the hydraulic pump will run constantly. On MF 65 Tractors, after Serial No. 692 932, also MF 50 Tractors after Serial No. 533 422, the clutch rod clevis pin can be placed in the lower hole, (No. 2, Fig. 2) of the clutch release shaft arm to have a constant-running hydraulic pump.

CAUTION: Do not attempt to operate power take-off implements with the clutch pedal linkage set, as mentioned above. Using this setting prohibits the operator from disengaging the PTO shaft with the clutch pedal. When the clutch rod clevis pin is in the normal operating position (Nos. 1, Fig. 1 and Fig. 2), the operation of the clutch is normal - fully releasing the primary and secondary clutches.

SERVICING THE CLUTCH RELEASE MECHANISM

Removing the clutch release mechanism on 65 Tractors prior to Serial No. 692 932.

1. Split tractor between engine and transmission.

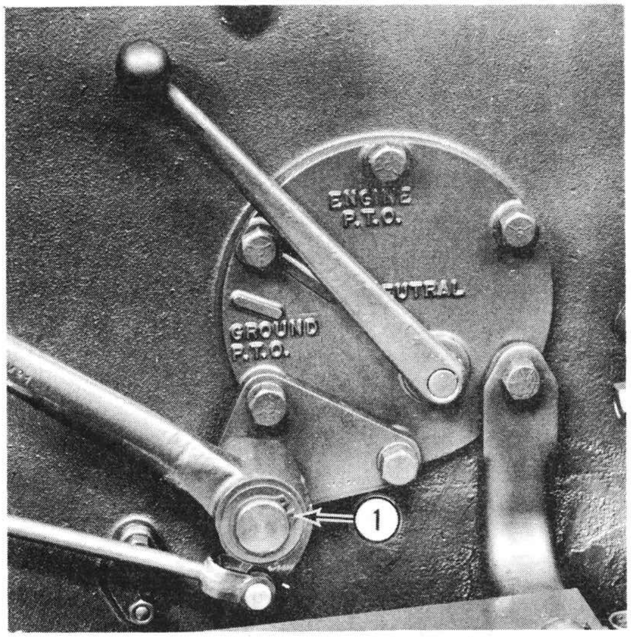

Fig. 6 – Pivot Pin Assembly Early MF 65
1. Snap Ring

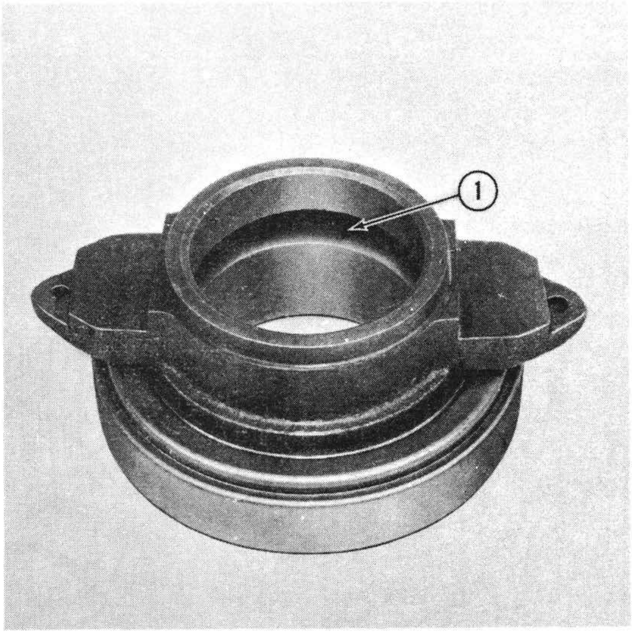

Fig. 8 – Release Bearing Carrier Assembly
1. Groove

2. Remove clevis pin (No. 12) attaching the pull rod clevis (No. 11) to the clutch release shaft arm (No. 10, Fig. 5).

3. Remove the clutch release shaft arm from the clutch release shaft (No. 8, Fig. 5).

4. Remove the release bearing carrier springs (No. 5, Fig. 5) and slide the release bearing and carrier off the drive shaft housing.

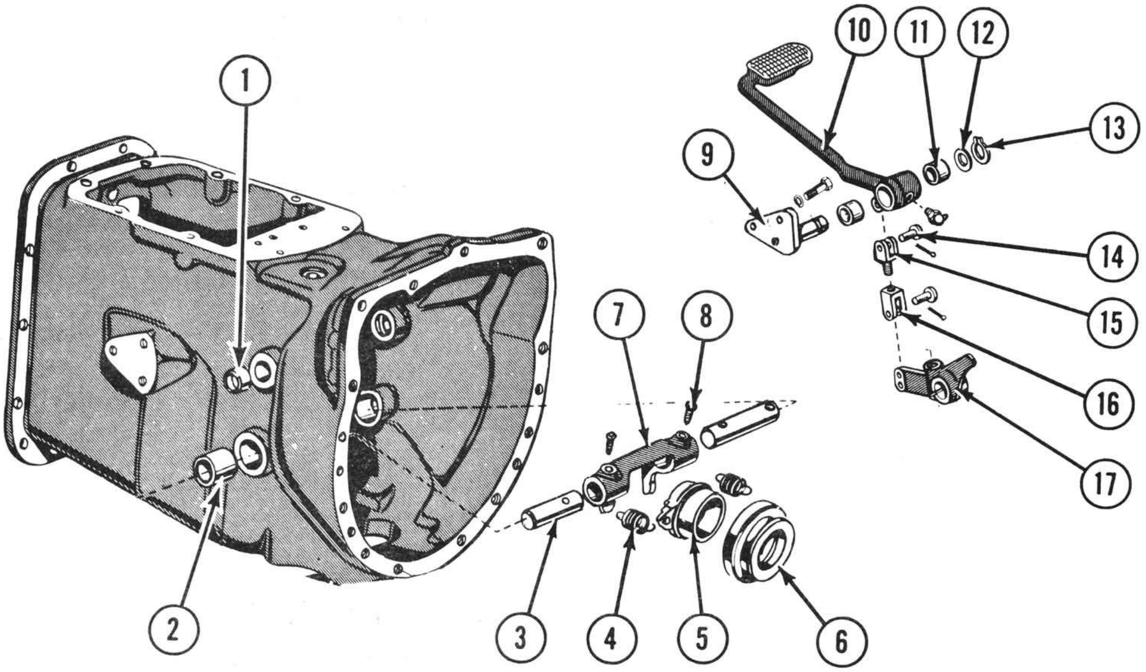

Fig. 7 – Release Mechanism Nomenclature Late MF 65 and Late MF 50

1. Bushing
2. Bushing
3. R.H. Release Shaft
4. Return Spring
5. Release Bearing Carrier
6. Release Bearing
7. Release Bearing Fork
8. Set Screw
9. Pedal Pivot Assembly
10. Clutch Pedal
11. Bushing
12. Thrust Washer
13. Snap Ring
14. Clevis Pin
15. Clevis Rod Assembly
16. Clevis
17. Release Shaft Arm

5. Remove the set screws and slide shafts (Nos. 2 and 8) from the transmission housing, and the release bearing fork (No. 4, Fig. 5).

6. To remove clutch pedal, take off snap ring (No. 1, Fig. 6) and pivot pin washer (No. 18, Fig. 5). Slide the pedal off pivot pin assembly (No. 15, Fig. 5). Refer to Fig. 7 to remove clutch pedal mechanism on MF 65 Tractors, after Serial No. 692 932, also MF 50 Tractors, after Serial No. 533 422.

INSPECTING THE CLUTCH RELEASE MECHANISM

1. Examine the release bearing for damage and freedom of movement.

2. Check the release mechanism for wear and damage.

ASSEMBLING AND INSTALLING THE CLUTCH RELEASE MECHANISM

Assemble and install the clutch release mechanism by reversing the previous procedure.

NOTE: Fill the groove (No. 1, Fig. 8) of the clutch release bearing carrier with "Lubriplate (Grade 70)" when reassembled.

GROUP II — SECTION B — PART 1

35, 50 AND 65 TRACTOR TRANSMISSION ASSEMBLY

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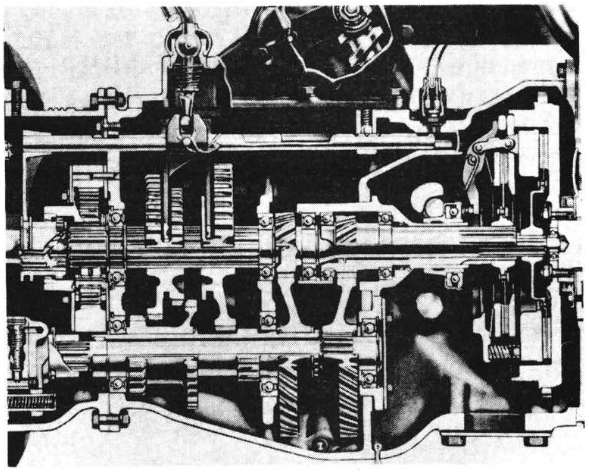
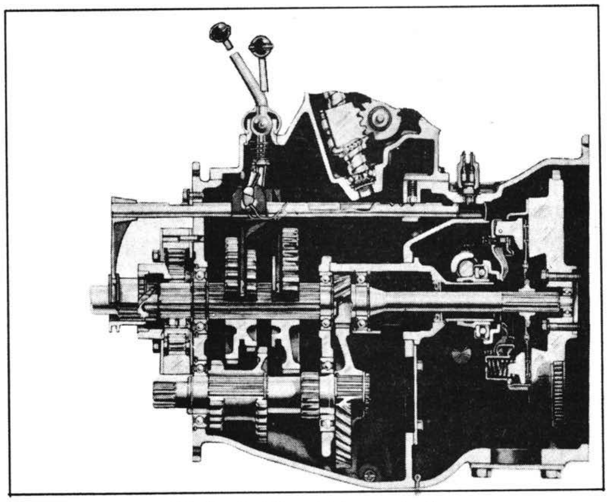


35 and 65 Dual Clutch Transmission



35 Single Clutch Transmission

REMOVING THE TRANSMISSION

To disassemble the transmission, it is necessary to split the tractor between the transmission housing and the engine as outlined in the Individual Engine Sections, Group I.

The following items are removed so the transmission can be removed from the differential center housing and mounted on a stand.

1. Drain the oil from the transmission and differential housings.

2. Remove step plates from either side of the tractor.

3. Remove exhaust system from manifold back through the muffler.

4. Remove brake pedals from right side of the tractor and the brake cross shaft. Remove brake rod assembly from both sides of the tractor.

NOTE: To remove the brake cross shaft, take out the woodruff key on one side of the tractor and slide the shaft out of the opposite side of the tractor.

5. Remove the neutral safety switch (No. 1, Fig. 1) from the transmission housing.

6. Attaching an overhead crane to the steering column as shown in Fig. 1, remove the attaching bolts and lift off the steering gear mechanism and instrument panel as a unit.

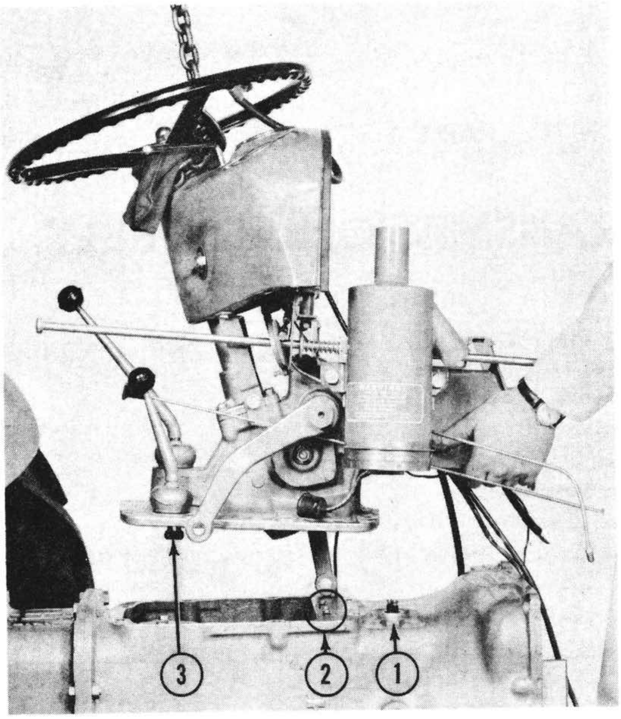


Fig. 1 Removing Steering Mechanism
1. Neutral Safety Switch
2. Detent Springs
3. Lower Ends of Shift Levers

NOTE: Make sure the steering mechanism is lifted straight up until the gear shift levers (No. 3, Fig. 1) are disengaged.

7. Place a floor jack under the differential center housing. Remove the attaching bolts and separate the transmission from the differential center housing as shown in Fig. 2.

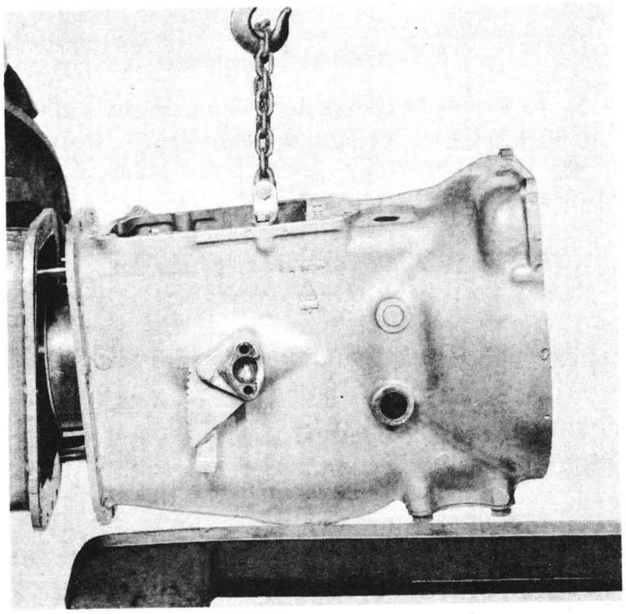


Fig. 2 Separating Transmission From Differential

INSPECTING THE TRANSMISSION

Whenever the transmission is disassembled, the following items should be checked:

1. Inspect the gears for signs of chipped or missing teeth. Replace as required.

2. Inspect all bearings in the transmission for signs of damage and excessive wear. Replace as needed.

3. Inspect the oil seals in the main drive shaft retainer assembly for damage and signs of leakage. Replace the seals.

4. Check all thrust washers for excessive wear and chafing. Replace as required.

CHANGES TO REVERSE GEAR CLUSTER

All tractors after Serial No. 171549 are supplied with an improved reverse gear cluster. The improved parts are not interchangeable individually with the previously produced parts and therefore, all three parts, the main shaft low speed gear, the reverse cluster, and the countershaft, must be serviced as a unit. Also the improved cluster uses 56 loose needle bearings; the earlier production parts use caged needle bearings.

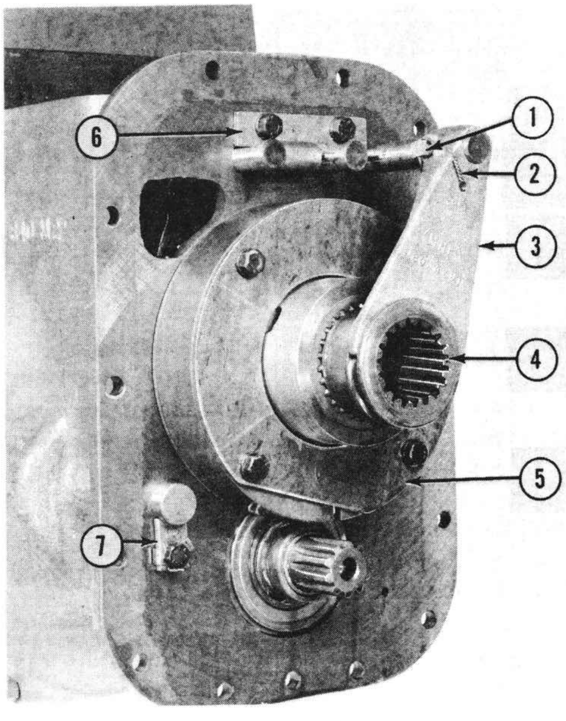


Fig. 3 Rear View of Transmission
1. Lock Screw
2. Lock Wire
3. Planetary Shifter Fork
4. Planetary Shift Coupler
5. Planetary Gear Assembly
6. Stop Plate and Selector Pin Lock
7. Reverse Gear Shaft Stop

DISASSEMBLING THE TRANSMISSION

1. Remove the detent springs (No. 2, Fig. 1)
2. Insert a magnetized rod in the holes where the springs were located, lift out the detent pins.
3. Remove the lock wire (No. 2, Fig. 3) and lock screw (No. 1, Fig. 3) from the planetary shifter fork (No. 3, Fig. 3).
4. Remove the planetary shifter fork and the shift coupler (No. 4, Fig. 3).
5. Remove the attaching cap screws and remove the planetary gear assembly (No. 5, Fig. 3).

> *NOTE: The planetary gear assembly is dowelled to the transmission case but can be easily separated by using two screw drivers as shown in Fig. 4.*

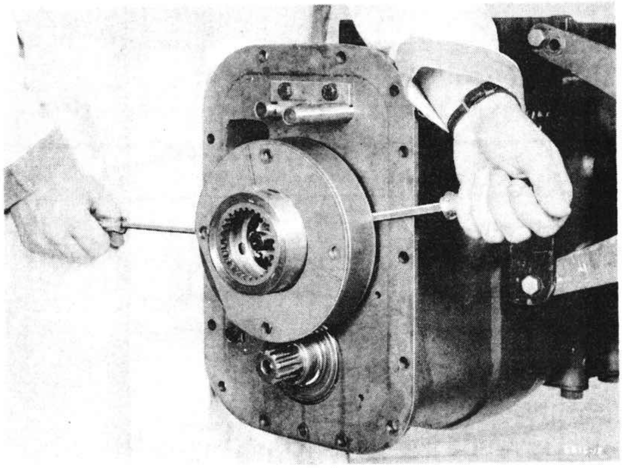


Fig. 4 Removing Planetary Gear Assembly

6. Remove the lock wires (No. 1, Fig. 5) and lock screws (No. 2, Fig. 5) from the shifter forks (No. 4, Fig. 12) and the planetary selector (No. 3, Fig. 12).
7. Remove the stop plate and selector pin lock (No. 6, Fig. 3) at the rear of the transmission.

> *NOTE: Once the stop plate is removed, the lock pin (No. 5, Fig. 12) may be slid out from either side of the stop plate.*

8. Remove the shift rails (Nos. 14, 15, 17, Fig. 12) and the shifter forks (No. 4, Fig. 12) from the transmission as shown in Fig. 6.
9. Note Figs. 7, 8, 9, 10, and 11. Observe the "power flow" through the transmission as the transmission is placed in the different gears. Notice the PTO "power flow" shown in Fig. 7.

> *NOTE: The reverse gear cluster and shaft have been removed from all illustrations except Fig. 8 so the "power flow" through the transmission may be seen.*

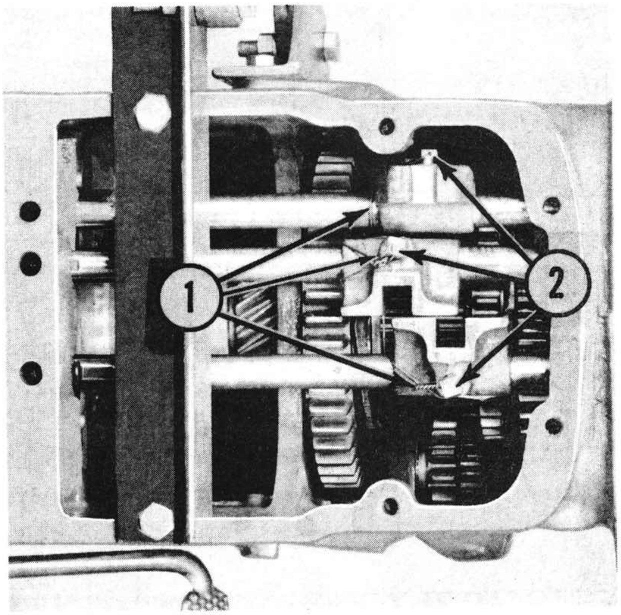


Fig. 5 Releasing Shift Rails
1. Lock Wire 2. Lock Screw

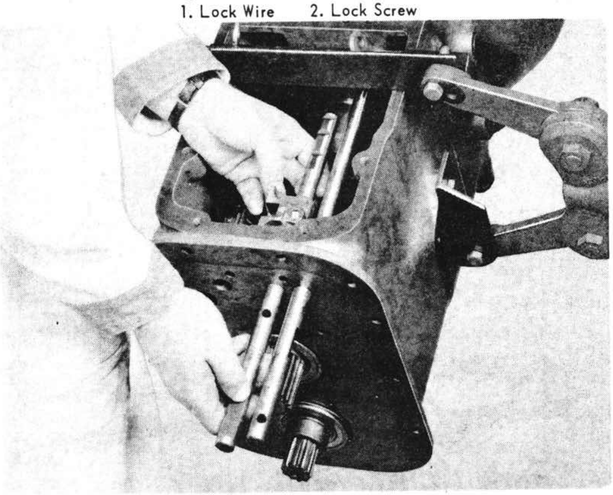


Fig. 6 Removing Shift Rails

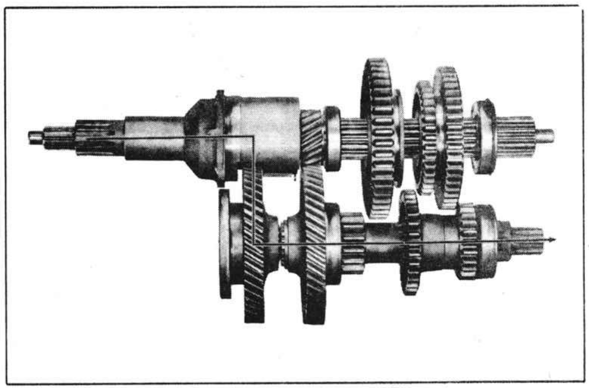


Fig. 7 Transmission Neutral Position

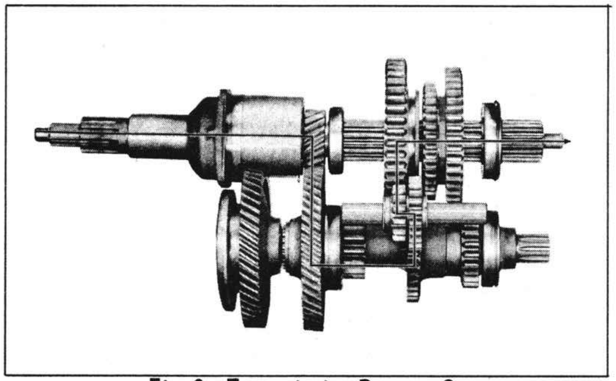


Fig. 8 Transmission Reverse Gear

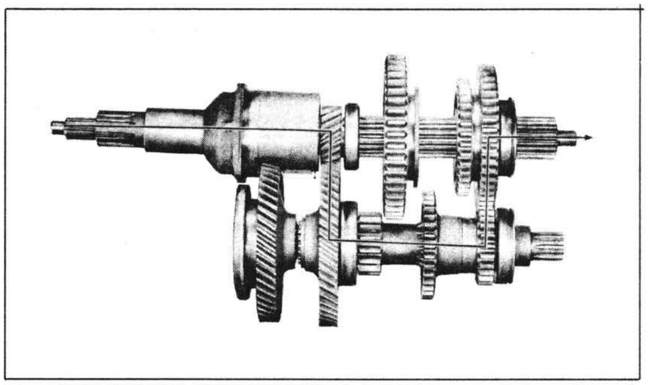


Fig. 10 Transmission 2nd Gear

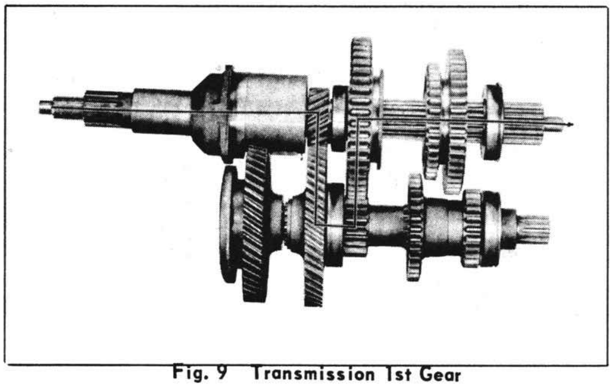


Fig. 9 Transmission 1st Gear

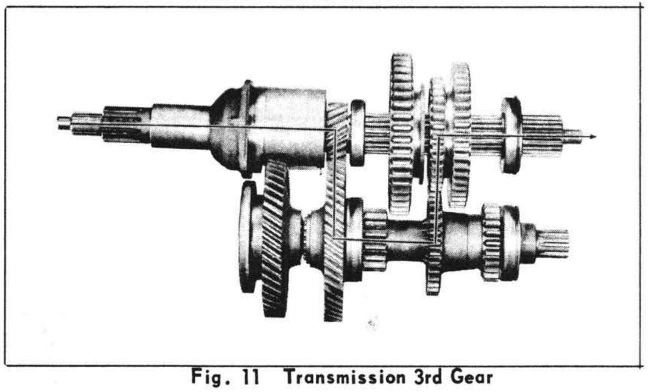


Fig. 11 Transmission 3rd Gear

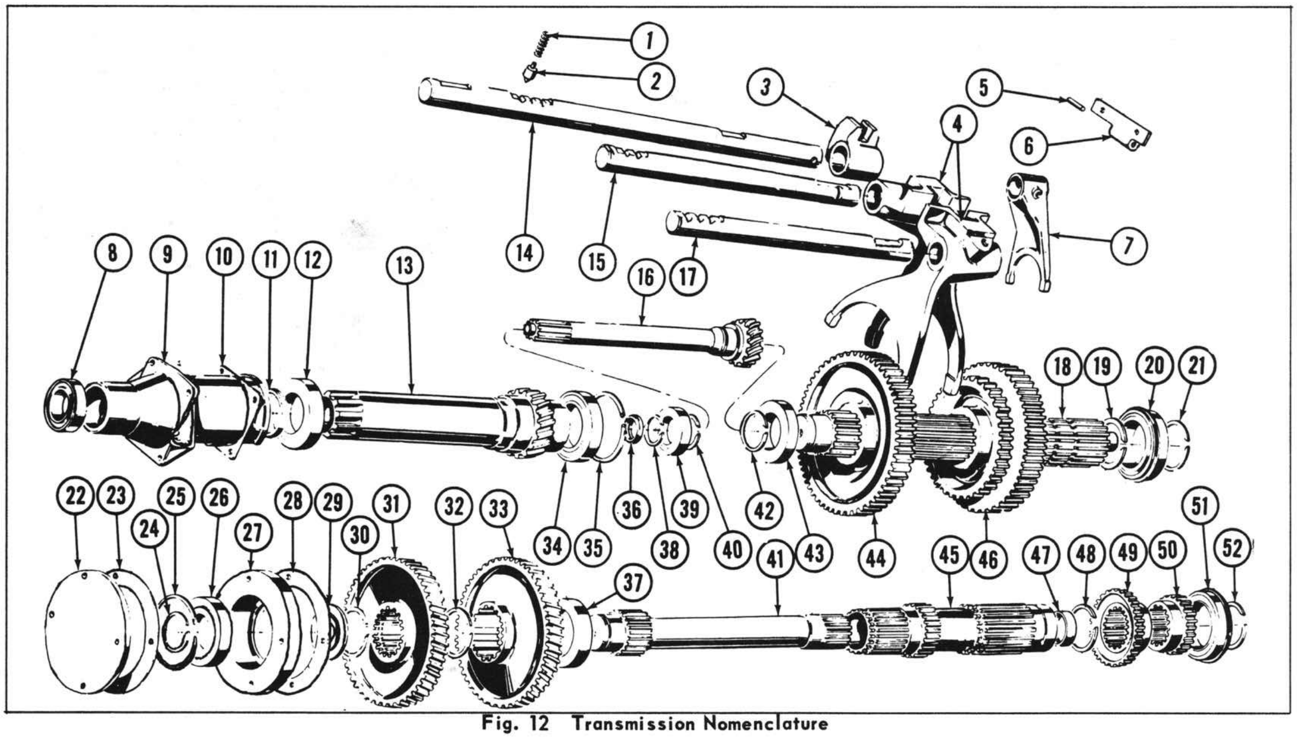


Fig. 12 Transmission Nomenclature

1. Detent Spring
2. Detent Pin
3. Planetary Selector
4. Shifter Forks
5. Selector Pin Lock
6. Stop Plate
7. Planetary Shifter Fork
8. Clutch Pilot Bearing
9. Retainer Housing
10. Retainer Housing Gasket
11. Oil Seal
12. Ball Bearing
13. PTO Drive Shaft
14. Planetary Shift Rail
15. 1st-Reverse Gear Shift Rail
16. Main Drive Shaft
17. 2nd-3rd Gear Shift Rail
18. Main Shaft
19. Snap Ring
20. Ball Bearing
21. Snap Ring
22. Bearing Housing Cover
23. Housing Cover Gasket
24. Snap Ring
25. Snap Ring
26. Ball Bearing
27. PTO Bearing Housing
28. Bearing Housing Gasket
29. Thrust Washer
30. Snap Ring
31. PTO Drive Gear
32. Snap Ring
33. Countershaft Main Drive Gear
34. Ball Bearing
35. Snap Ring
36. Oil Seal
37. Ball Bearing
38. Snap Ring
39. Ball Bearing
40. Snap Ring
41. Live PTO Shaft
42. Snap Ring
43. Ball Bearing
44. 1st-Reverse Sliding Gear
45. Countershaft
46. 2nd-3rd Sliding Gear
47. Caged Needle Bearing
48. Snap Ring
49. 3rd Gear Pinion
50. 2nd Gear Pinion
51. Ball Bearing
52. Snap Ring

10. Remove the front power take-off bearing cap (No. 22, Fig. 12).

11. Remove the snap ring (No. 24, Fig. 12) from the end of the live power shaft.

12. Remove the PTO bearing housing (No. 27, Fig. 12) by using two pusher cap screws (No. 1, Fig. 13) in the tapped holes of the housing as shown in Fig. 13.

> *NOTE: The single clutch transmission doesn't contain a PTO bearing or bearing housing.*

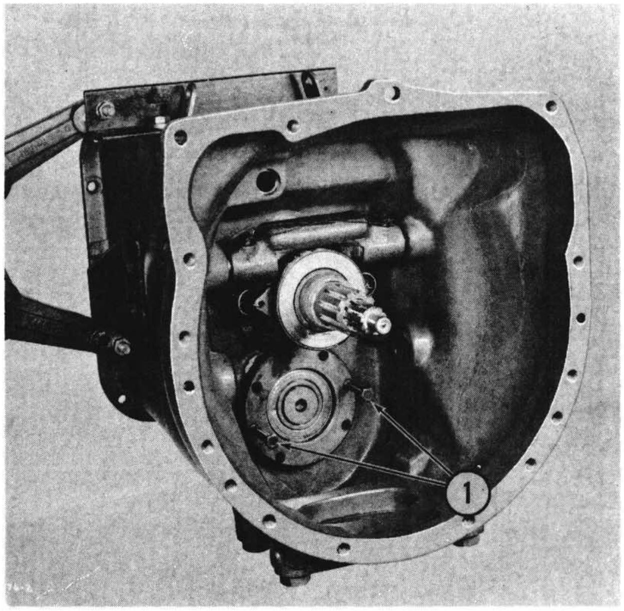


Fig. 13 Removing PTO Bearing Housing
1. Pusher Cap Screws

13. Using internal snap ring pliers, remove the internal snap ring (No. 30, Fig. 12) from the PTO main drive gear (No. 31, Fig. 12).

> *NOTE: The single clutch transmission doesn't have a PTO drive gear.*

14. Remove the live PTO shaft (No. 41, Fig. 12) by sliding it out of the front of the transmission as shown in Fig. 14.

> *NOTE: This allows the PTO drive gear (No. 2, Fig. 15) to drop down as shown in Fig. 15 so the main drive shaft retainer assembly can be removed. There isn't any live PTO shaft in the single clutch transmission.*

15. Using pliers, disconnect the clutch release bearing carrier return spring (Nos. 3, 6, Fig. 16) from the bearing carrier.

16. Slide the clutch release bearing and carrier (Nos. 4, 5, Fig. 16) from the end of the shaft as a unit.

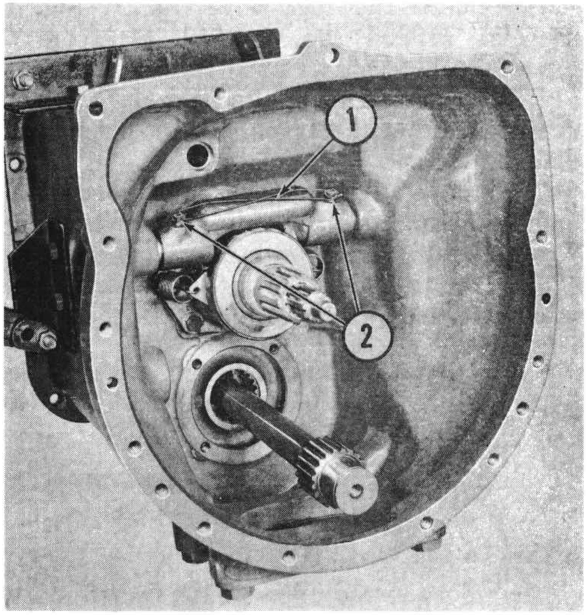


Fig. 14 Removing Live PTO Shaft
1. Lock Wire 2. Lock Screw

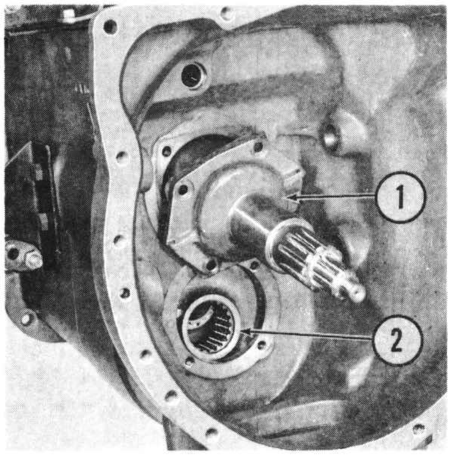


Fig. 15 Removing Drive Shaft Retainer
1. Main Drive Shaft Retainer Assembly 2. PTO Main Drive Gear

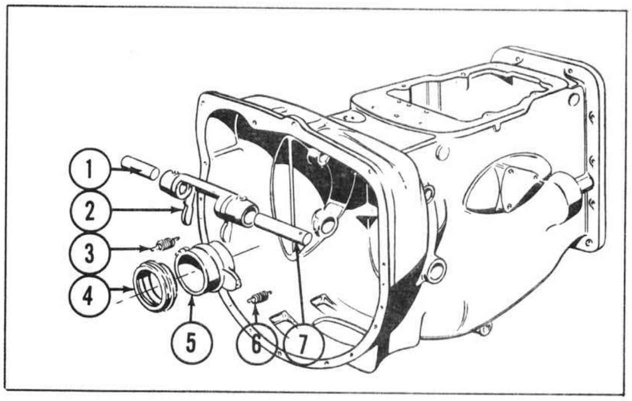


Fig. 16 Transmission Housing
1. Clutch Fork Shaft
2. Clutch Release Fork
3. Clutch Release Spring
4. Clutch Release Bearing
5. Clutch Release Bearing Carrier
6. Clutch Release Spring
7. Clutch Fork Shaft

17. Remove the lock wire (No. 1, Fig. 14) and lock screws (No. 2, Fig. 14) from the clutch release shaft fork (No. 2, Fig. 16).

18. Slide the clutch shafts (Nos. 1, 7, Fig. 16) out the side of the transmission housing and remove the fork.

19. Remove the attaching cap screws and remove the main drive shaft retainer assembly (No. 1, Fig. 15) as shown in Fig. 15.

20. Place a block between the two sliding main shaft gears (Nos. 44, 46, Fig. 12) as shown in Fig. 17.

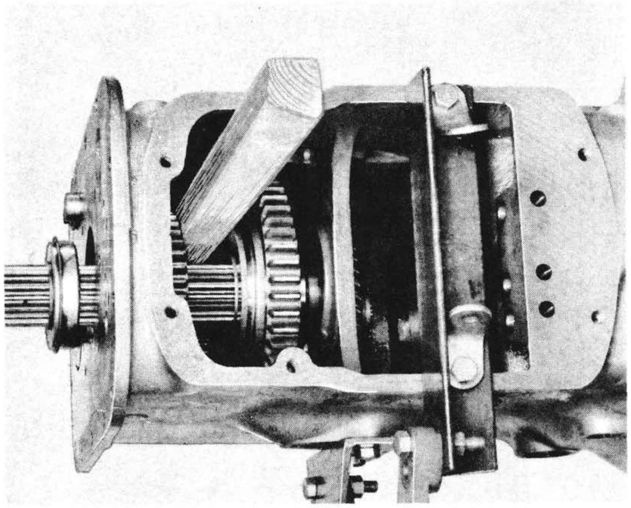


Fig. 17 Removing the Main Shaft

21. Remove the snap ring (No. 42, Fig. 12) from the front end of the main shaft.

22. Using a brass rod 20 to 24 inches long, carefully drive the main shaft (No. 18, Fig. 12) from the transmission, toward the rear, as shown in Fig. 17.

23. Remove the sliding gears (Nos. 44, 46, Fig. 12) and the front PTO gear (No. 31, Fig. 12) from the transmission housing.

24. The rear bearing (No. 20, Fig. 12) on the main shaft (No. 18, Fig. 12) may be removed by pressing the bearing toward the front or over the long part of the shaft as shown in Fig. 18.

25. Remove the snap ring (No. 32, Fig. 12) from the front of the countershaft main drive gear (No. 33, Fig. 12).

26. Remove the countershaft main drive gear by sliding it off the front of the countershaft.

27. Remove the snap ring (No. 52, Fig. 12) from the rear of the countershaft.

28. Using OTC Step Plate No. 630-6, carefully drive the countershaft forward, out of the rear bearing (No. 51, Fig. 12).

NOTE: The countershaft is a solid one piece shaft in the single clutch transmission and is removed in the same manner that the countershaft is removed in the dual clutch transmission. It is not necessary to use OTC Step-Plate No. 630-6 when removing the countershaft from the single clutch transmission. Use a punch in the center hole of the countershaft at the rear of the transmission.

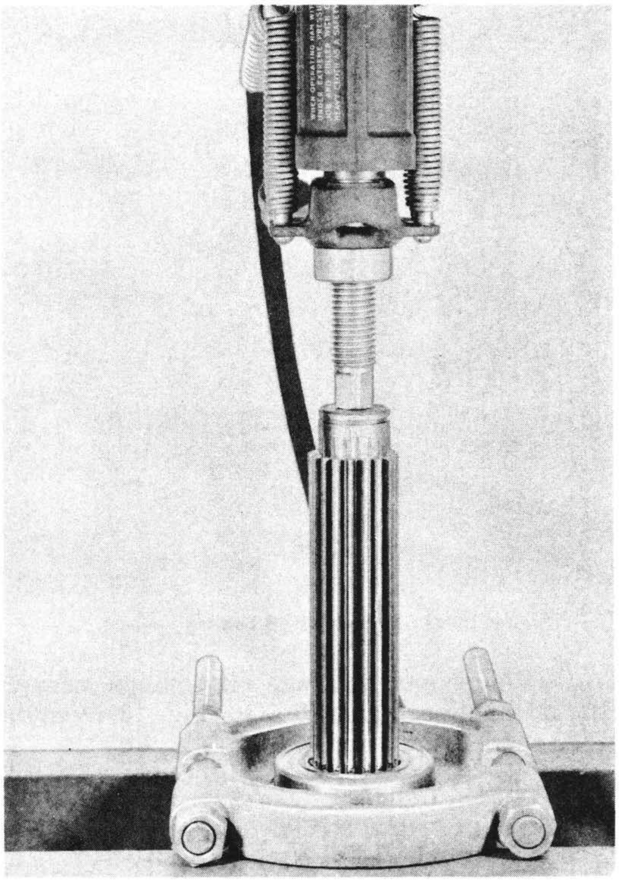


Fig. 18 Removing the Main Shaft Bearing

29. Remove the two countershaft gears (Nos. 49, 50, Fig. 12).

30. Remove the countershaft and front bearing (No. 37, Fig. 12) from the front of the transmission as shown in Fig. 19.

31. Remove the attaching cap screw and the reverse shaft stop (No. 7, Fig. 3) at the rear of the transmission.

32. Withdraw the reverse gear cluster shaft shown in Fig. 20 from the rear of the transmission.

*NOTE: The reverse gear cluster is suspended on 56 loose needle bearings. Care must be taken not to lose any of these bearings. See Page **2** for differences in the reverse gear clusters.*

33. Remove the rear countershaft bearing (No. 51, Fig. 12) from the rear of the transmission.

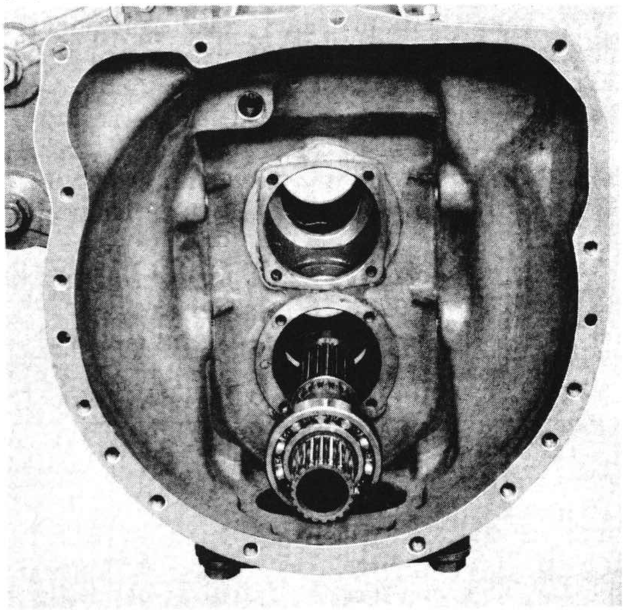


Fig. 19 Removing the Countershaft

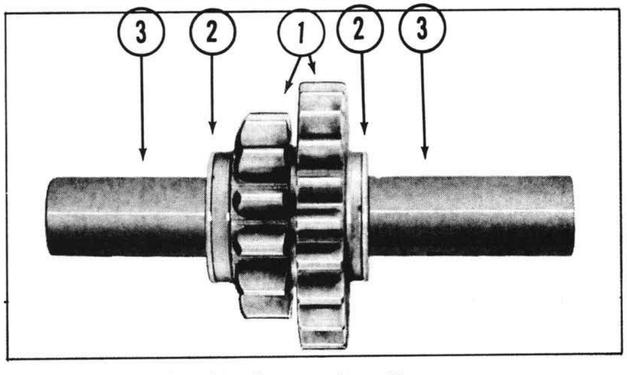


Fig. 20 Reverse Gear Cluster
1. Gear Cluster
2. Thrust Washer
3. Shaft

ASSEMBLING THE TRANSMISSION

1. Install the reverse gear cluster with a thrust washer (No. 2, Fig. 20) on each side of the cluster and the large gear toward the rear of the transmission as shown in Fig. 21. Install the shaft, stop and cap screw.

NOTE: To install the needle bearings in the hubs of the reverse gear cluster, use a light coating of grease.

2. Install the snap ring (No. 48, Fig. 12) on the countershaft.

3. Work the countershaft and front bearing through the front of the transmission housing far enough to install the two countershaft gears. The countershaft in the single clutch is a one piece shaft.

NOTE: Install the countershaft gears with the small gear to the rear with the long hubs of the gears together as shown in Fig. 23.

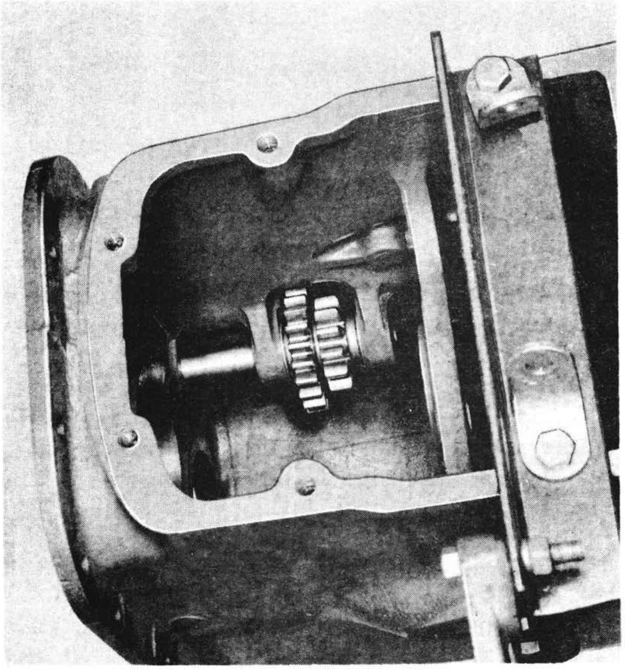


Fig. 21 Reverse Gear Cluster Installed

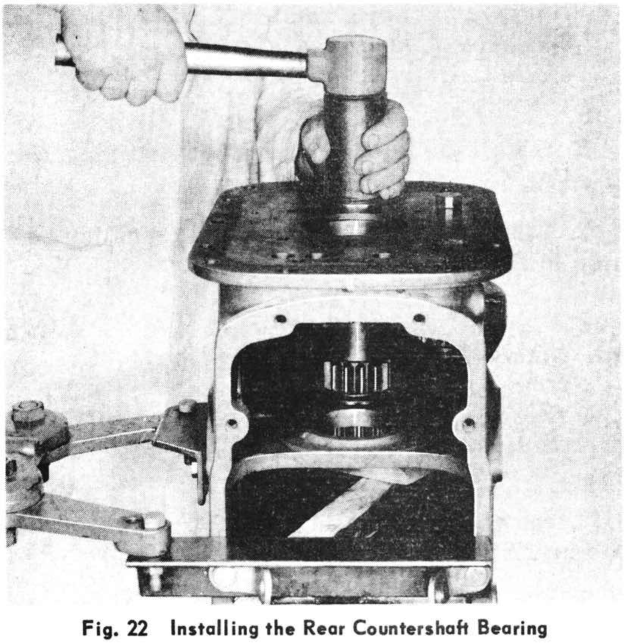


Fig. 22 Installing the Rear Countershaft Bearing

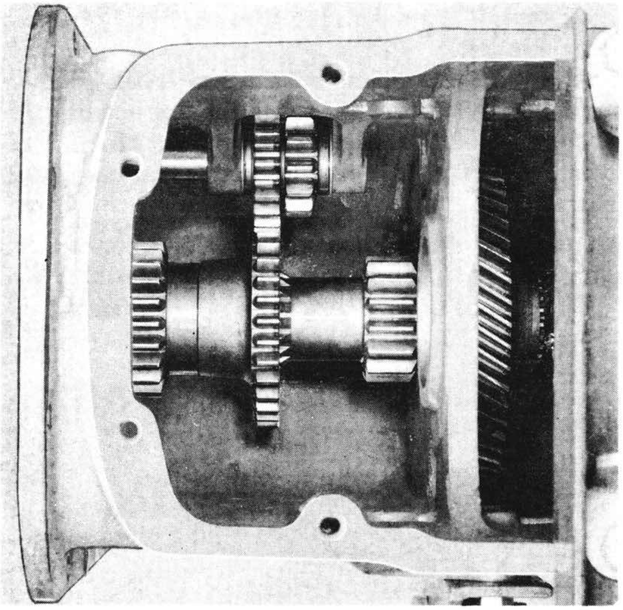


Fig. 23 Countershaft Installed

4. Push the countershaft in as far as possible and wedge a wooden block in the front compartment of the transmission, as shown in Fig. 22, to prevent the countershaft from moving forward.

5. Using a piece of 2 inch pipe (inside diameter) carefully drive the rear countershaft bearing (No. 51, Fig. 12) into place as shown in Fig. 22.

NOTE: Install the bearing with the snap ring to the outside of the transmission.

CAUTION: Whenever using pipe to drive in a bearing, make sure that the pipe contacts the inner race only. The pipe end should be threaded and a cap installed. Drive against the cap.

6. Install the rear countershaft snap ring (No. 52, Fig. 12) and remove the wedge.

7. Place the sliding main shaft gears in position in the transmission.

NOTE: The larger gear goes to the front with the fork groove to the rear. The two gear cluster is installed with the larger gear to the rear. See Fig. 7.

8. Install the snap ring (No. 19, Fig. 12) on the transmission main shaft.

9. Install the rear bearing (No. 20, Fig. 12) on the transmission main shaft.

NOTE: Start the rear end of the shaft into the bearing and press the shaft in until the rear snap ring (No. 21, Fig. 12) will fit into the groove.

10. Install the transmission main shaft and rear bearing as a unit from the rear of the transmission. Place the sliding gears on the shaft as it is inserted into the transmission.

11. Install the planetary gear assembly by placing the front ring gear thrust washer (No. 4, Fig. 24) into the recess on the dowelled side of the planetary ring gear (No. 3, Fig. 24).

12. Place the front ring gear cover (No. 2, Fig. 24) and the front cover shim (No. 1, Fig. 24) over the dowels of the planetary ring gear.

NOTE: The cover plate is turned so the oil grooves face the bronze thrust washer. The shim is next to the transmission housing.

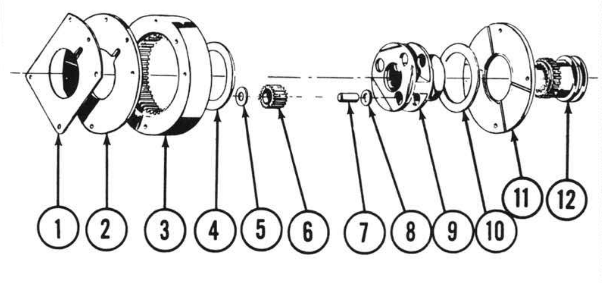


Fig. 24 Planetary Gear Assembly

1. Shim
2. Front Ring Gear Cover
3. Planetary Ring Gear
4. Ring Gear Thrust Washer
5. Pinion Gear Thrust Washer
6. Pinion Gear
7. Pinion Gear Shaft
8. Pinion Gear Thrust Washer
9. Pinion Gear Carrier
10. Ring Gear Thrust Washer
11. Rear Ring Gear Cover
12. Planetary Shift Coupler

13. Holding the thrust washer into the recess of the ring gear with the finger tips, lightly tap the dowelled ring gear into place at the rear of the transmission with a lead or bronze hammer as shown in Fig. 25.

NOTE: The thrust washer must remain in the ring gear recess and be free to rotate.

14. Install the pinion carrier assembly (No. 9, Fig. 24) in the ring gear.

15. Install the rear ring gear thrust washer (No. 10, Fig. 24) in the recess of the ring gear.

16. Install the rear cover plate (No. 11, Fig. 24) with the grooves facing the thrust washer and secure with the appropriate cap screws.

NOTE: Make sure the thrust washer is not jarred from the recess in the ring gear while installing the rear cover plate.

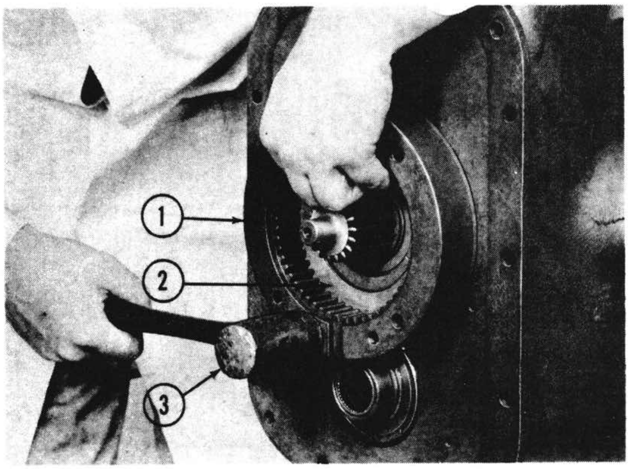


Fig. 25 Installing the Planetary Ring Gear
1. Planetary Ring Gear
2. Thrust Washer
3. Lead Hammer

17. Use a suitable piece of pipe (1-5/8 inch inside diameter) and drive the front main shaft bearing (No. 43, Fig. 12) into position.
18. Install snap ring (No. 42, Fig. 12).
19. Install the countershaft main drive gear (No. 33, Fig. 12) with the long hub toward the front.

NOTE: The PTO drive gear has an internal snap ring groove.

20. Install the snap ring (No. 32, Fig. 12) on the front end of the countershaft.
21. Position the PTO drive gear (No. 31, Fig. 12) in the transmission housing with the snap ring groove towards the front.
22. Use a new or serviceable gasket and install the main drive shaft retainer assembly and tighten the cap screws.
23. Install the live PTO shaft (No. 41, Fig. 12).
24. Wedge a block behind the PTO drive gear to hold it as far forward as possible.

25. Install the snap ring (No. 30, Fig. 12) in the groove of the PTO drive gear and remove the wedge.

26. Install the thrust washer (No. 29, Fig. 12) on the end of the live PTO shaft.

NOTE: The thrust washer must be positioned so that the small shoulder will face the bearing.

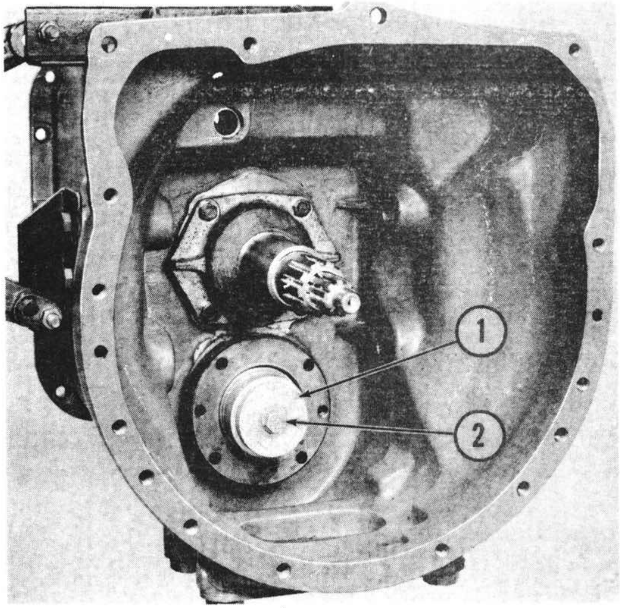


Fig. 26 Installing PTO Bearing Housing
1. Spacers
2. Bolt

27. Position a new or serviceable gasket (No. 28, Fig. 12) on the front bearing housing (No. 27, Fig. 12) and draw the housing into position using a bolt with spacers in the tapped hole in the end of the shaft as shown in Fig. 26.

NOTE: Draw the bearing housing in so that two cap screws may be installed.

28. Install the two cap screws and tighten the bearing housing into place, as shown in Fig. 27.
29. Remove the bolt and spacers from the tapped hole in the shaft.

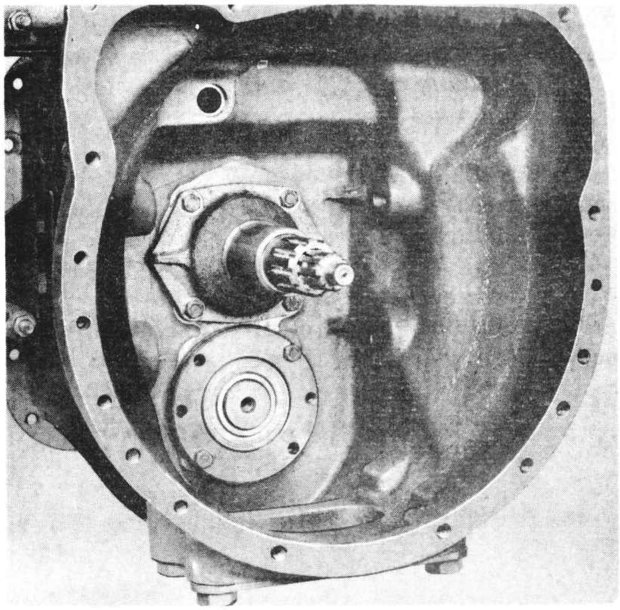


Fig. 27 Tightening the Bearing Housing In Position

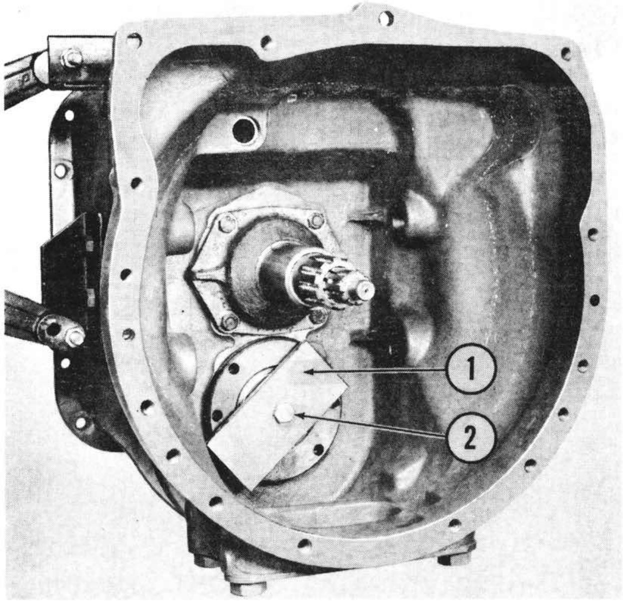


Fig. 28 Pulling Live PTO Shaft Into Position
1. Steel Plate 2. Bolt

30. By using a steel plate across the two bolt heads, and a bolt in the tapped hole in the end of the shaft, draw the shaft through the bearing enough to install the snap ring as shown in Fig. 28.

31. Install the snap ring (No. 24, Fig. 12) to the front end of the live PTO shaft.

32. Remove the cap screws securing the bearing housing to the transmission housing.

33. Use a new or serviceable gasket, (No. 23, Fig. 12) install the cover plate (No. 22, Fig. 12) and tighten the cap screws.

34. Install the clutch release shaft fork as shown in Fig. 16.

> *NOTE: The longer clutch pedal shaft is installed on the left side of the transmission housing.*

35. Install the set screws (No. 1, Fig. 29) and lock with wire as shown in Fig. 29. Install the return springs.

36. Install the planetary shift rail (No. 14, Fig. 12) and selector (No. 3, Fig. 12).

37. Position the selector and tighten the set screw (No. 2, Fig. 5) and lock with wire.

> *NOTE: Do not install the planetary shift fork at this time.*

38. Install the two transmission forks (No. 4, Fig. 12).

> *NOTE: The forks are identical and may be installed in either location.*

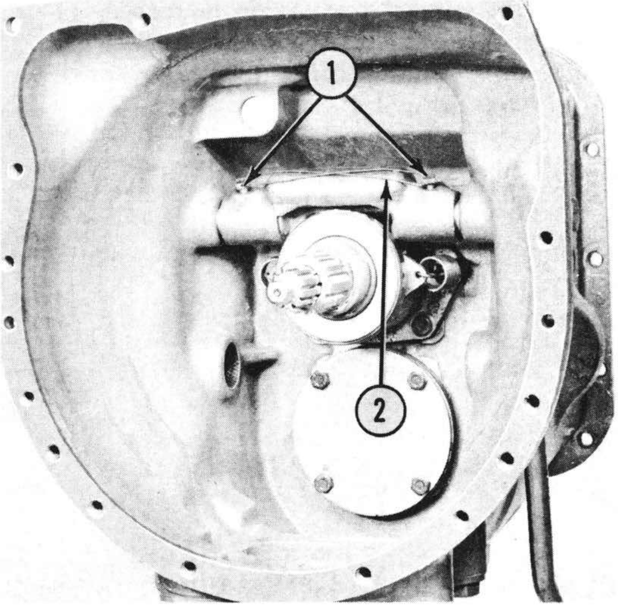


Fig. 29 Clutch Release Shaft Fork and Bearing Installed
1. Set Screw 2. Lock Wire

39. Install the two transmission shift rails (Nos. 15, 17, Fig. 12).

> *NOTE: Install the shift rails with the milled flat for the lock to the rear of the transmission and on top. Make sure that the two selector lock grooves in the rail are toward the center.*

40. Install the set screws (No. 2, Fig. 5) locking the shifter forks to the shift rails. Lock with wire.

41. Install the shifter rail stop and selector lock at the rear of the transmission as shown in Fig. 3.

42. Install the planetary shift coupler (No. 4, Fig. 3) and shift fork No. 3, Fig. 3).

43. Tighten the set screw (No. 1, Fig. 3) locking the shift fork to the planetary shift rail. Lock with wire.

44. Assemble the transmission to the center differential housing using a new or serviceable gasket.

> *NOTE: This may be accomplished by removing the PTO shifter lever and cover as a unit from the left side of the differential housing. Install the transmission to the differential housing without the rear drive shaft and coupler assembly. Place the rear drive shaft and coupler assembly into position after the transmission has been joined to the differential center housing through the PTO shifter lever and cover assembly opening.*

> *CAUTION: Make sure a cotter pin of the proper size is placed through the rear drive coupler after the coupler has been installed.*

45. Install the detent pins (No. 2, Fig. 12) and springs (No. 1, Fig. 12) as shown in Fig. 12.

46. Use a new or serviceable gasket; install the steering assembly and instrument panel as a unit.

> *NOTE: Make sure the shift levers are positioned properly in their respective selectors when lowering the steering and instrument panel assembly.*

47. Connect the planetary shifter safety switch wires and replace the rubber boot.

48. Complete the reassembly operation by reversing the remaining steps in "Removing the Transmission."

MAIN DRIVE SHAFT RETAINER ASSEMBLY AND COUNTERSHAFT DRIVE GEARS

REMOVAL OF MAIN DRIVE SHAFT RETAINER ASSEMBLY

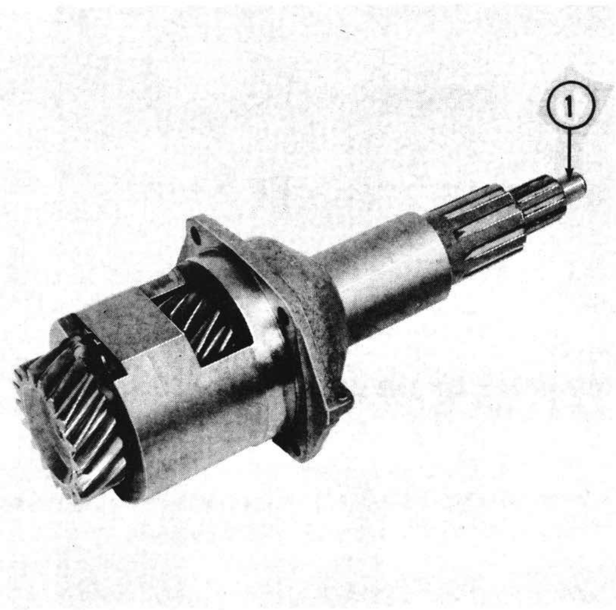


Fig. 30 Main Drive Shaft Retainer Assembly
1. Bearing Surface

To remove the main drive shaft retainer assembly, shown in Fig. 30, it is necessary to split the tractor between the engine and the transmission housing. After splitting the tractor:

1. Remove the front power take-off bearing housing cap (No. 22, Fig. 12).

2. Remove the snap ring (No. 24, Fig. 12) from the end of the live power shaft.

3. Remove the PTO bearing housing (No. 27, Fig. 12) using two pusher cap screws in the tapped holes of the housing as shown in Fig. 13.

> *NOTE: No PTO bearing or bearing housing present in the single clutch transmission.*

4. Use internal snap ring pliers, and remove the internal snap ring (No. 30, Fig. 12) from the PTO main drive gear (No. 31, Fig. 12).

> *NOTE: No PTO drive gear present in the single clutch transmission.*

5. Remove the front PTO shaft (No. 41, Fig. 12) by sliding it from the front of the transmission as shown in Fig. 14.

> *NOTE: This allows the front PTO gear to drop down as shown in Fig. 15 so the main drive shaft retainer assembly can be removed. There is no front PTO shaft present in the single clutch transmission.*

6. Use pliers, disconnect clutch release bearing carrier return spring. (Nos. 3, 6, Fig. 16) from the bearing carrier.

7. Slide the clutch release bearing and carrier (Nos. 4, 5, Fig. 16) from the end of the shaft as a unit.

8. Remove the lock wire (No. 1, Fig. 14) and lock screws (No. 2, Fig. 14) from the clutch release shaft fork (No. 2, Fig. 16).

9. Slide the clutch shafts (Nos. 1, 7, Fig. 16) out the side of the transmission housing and remove the fork.

10. Remove the attaching cap screws and the main drive shaft retainer assembly (No. 1, Fig. 15) as shown in Fig. 15.

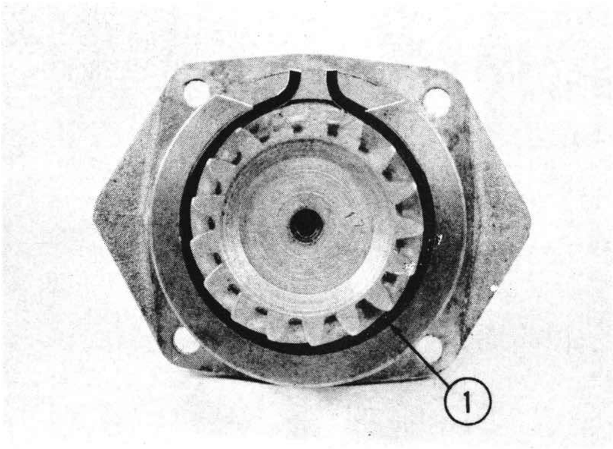


Fig. 31 Disassembly of Retainer Assembly
1. Snap Ring

DISASSEMBLY OF MAIN DRIVE SHAFT RETAINER ASSEMBLY

The main drive shaft retainer assembly, shown in Fig. 30, may be disassembled as follows:

1. Use a screw driver or a pair of pliers, and remove the snap ring (No. 1, Fig. 31) from the rear of the assembly and remove the main drive shaft (No. 1, Fig. 32) as shown in Fig. 32.

> *NOTE: It may be necessary to tap the main drive shaft to start it out of the retainer assembly. USE ONLY A BRASS HAMMER.*
>
> *CAUTION: The front section (No. 1, Fig. 30) of the main drive shaft is supported by the clutch pilot bearing in the flywheel. USE EXTREME CARE WHENEVER DRIVING AGAINST THIS SECTION OF THE MAIN DRIVE SHAFT.*

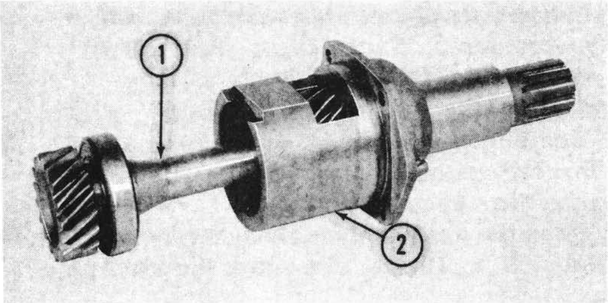


Fig. 32 Removing Main Drive Shaft
1. Main Drive Shaft 2. Retainer Assembly

The PTO shaft oil seal and Main Drive Shaft oil seal are now accessible and may be replaced.

2. Remove the internal snap ring (No. 1, Fig. 33).

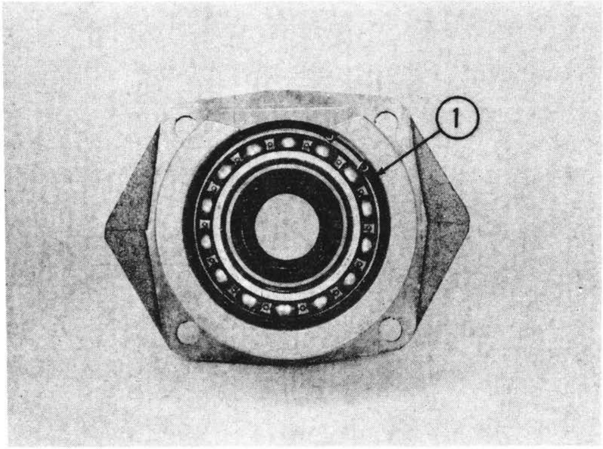


Fig. 33 Disassembly of Retainer Assembly
1. Snap Ring

3. Use a lead or brass hammer, and carefully drive the PTO main drive shaft from the retainer assembly housing as shown in Fig. 34.

If necessary, the roller bearing on the main drive shaft and the two roller bearings on the PTO main drive shaft can now be replaced.

> *NOTE: Always use a press when replacing roller bearings on the main drive shaft and the PTO main drive shaft.*

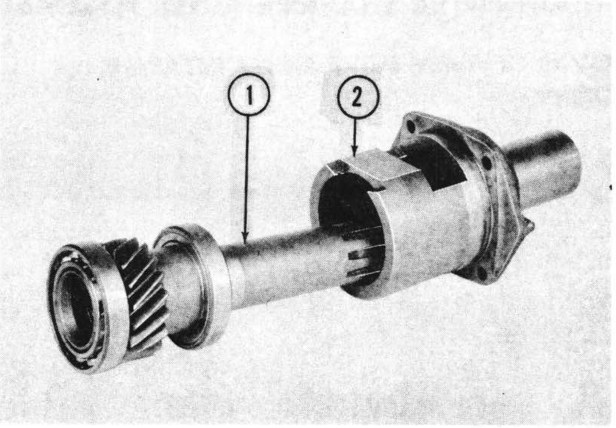


Fig. 34 Removing PTO Main Drive Shaft
1. PTO Main Drive Shaft 2. Retainer Assembly Housing

ASSEMBLY OF THE MAIN DRIVE SHAFT RETAINER

The main drive shaft retainer assembly shown in Fig. 35 may be assembled by reversing the preceding disassembly procedure.

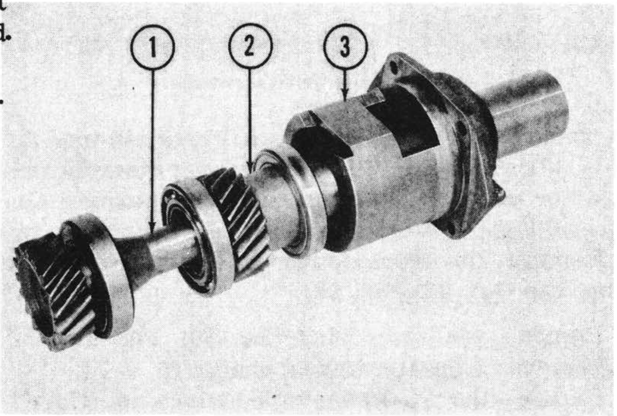


Fig. 35 Exploded View - Drive Shaft Retainer Assembly
1. Main Drive Shaft 3. Retainer Assembly Housing
2. PTO Main Drive Shaft

> *NOTE: It is very important that protective coverings, like those shown in Fig. 36, be used to cover the shaft splines while the shafts are being installed through the oil seals.*

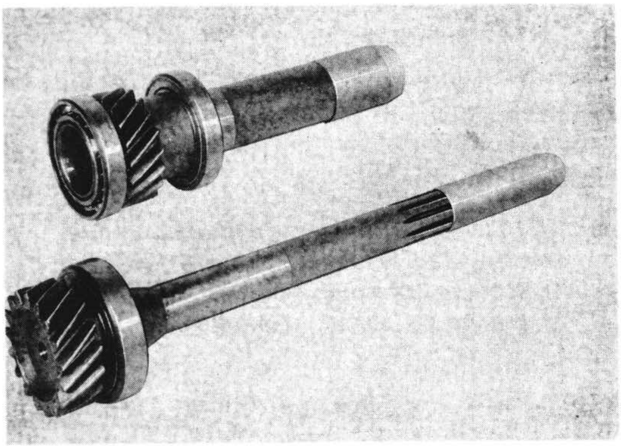


Fig. 36 Drive Shaft Protective Coverings

INSTALLING THE MAIN DRIVE SHAFT RETAINER ASSEMBLY

The main drive shaft retainer assembly may be installed by reversing the removal procedure.

> *NOTE: Make sure new or serviceable gaskets are used when replacing the PTO bearing housing, PTO bearing housing cap and the main drive shaft retainer assembly.*

REMOVAL OF COUNTERSHAFT DRIVE GEARS

1. Remove the steering gear assembly and instrument panel as a unit as outlined in "Removing the Transmission".
2. Remove the main drive retainer assembly as outlined in "Removal of Main Drive Shaft Retainer Assembly".
3. Remove the detent springs (No. 2, Fig.1).
4. Inserting a magnetized rod in the holes where the springs were located, lift out the detent pins.
5. Remove the lock wire (No. 2, Fig. 3) and lock screw (No. 1, Fig. 3) from the planetary shifter fork (No. 3, Fig. 3).
6. Remove the planetary shifter fork and the shift coupler (No. 4, Fig. 3).
7. Remove the attaching cap screws and the planetary gear assembly (No. 5, Fig. 3).

> *NOTE: The planetary gear assembly is dowelled to the transmission case but can be removed by using two screw drivers as shown in Fig. 4.*

8. Remove the lock wires (No. 1, Fig. 5) and lock screws (No. 2, Fig. 5) from the shifter forks (No. 4, Fig. 12) and the planetary selector (No. 3, Fig. 12).
9. Remove the stop plate and selector pin lock (No. 6, Fig. 3) at the rear of the transmission.

> *NOTE: When the stop plate is removed, the lock pin (No. 5, Fig. 12) may be removed from either side of the stop plate.*

10. Remove the shift rails (Nos. 14, 15, 17, Fig. 12) and the shifter forks (No. 4, Fig. 12) from the transmission as shown in Fig. 6.
11. Lift the PTO drive gear from the transmission housing.
12. Remove the snap ring (No. 32, Fig. 12) in front of the countershaft main drive gear (No. 33, Fig. 12).
13. Slide the gear forward, off the countershaft, and lift it from the transmission housing.

INSTALLING THE COUNTERSHAFT DRIVE GEARS

The countershaft drive gears may be installed by reversing the removal procedure.

> *NOTE: The PTO drive gear has an internal snap ring groove. Install the two countershaft main drive gears with the long hubs towards the front.*

THE PLANETARY GEAR ASSEMBLY

OPERATION OF THE PLANETARY GEAR ASSEMBLY

The planetary ring gear is attached to the transmission housing and cannot rotate. As the transmission main shaft rotates the planetary pinions, which are in constant mesh with the planetary ring gear, rotate. The carrier assembly travels at 1/4 the main shaft speed.

When the shift coupler is shifted to the rear it is in the low range position. The external splines of the coupler mate with the internal splines of the planetary carrier assembly. Therefore, the drive shaft between the transmission and the differential is traveling at the same rate of speed as the carrier assembly.

When the shift coupler is shifted to the front, it is in the high range position. The internal splines of the shift coupler mate with the splines of the transmission main shaft, causing the drive shaft between the transmission and the differential to travel at the same speed as the transmission main shaft.

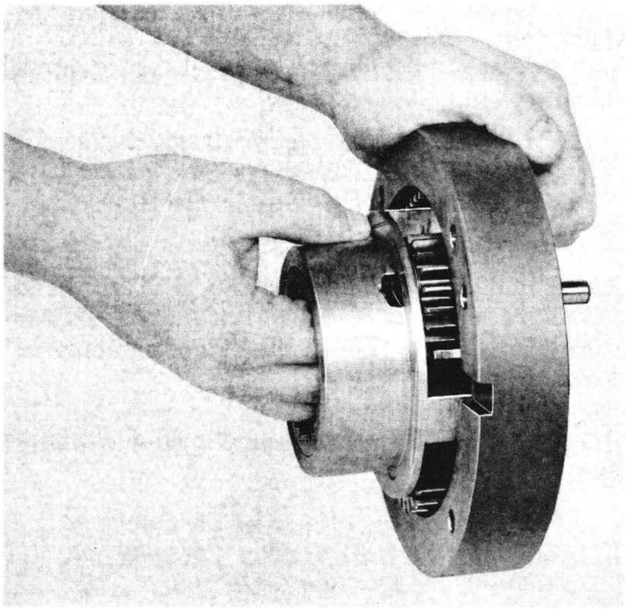


Fig. 37 Removing the Pinion Carrier Assembly

REMOVAL OF THE PLANETARY GEAR ASSEMBLY

The planetary gear assembly is at the rear of the transmission. If it is necessary to remove only the planetary gear assembly, the tractor has to be separated between the differential center housing and the transmission.

When the tractor has been separated and the rear of the transmission is exposed the planetary gear assembly may be removed as follows:

1. Remove lock wire (No. 2, Fig. 3) and lock screw (No. 1, Fig. 3) from the planetary shifter fork (No. 3, Fig. 3).
2. Remove the planetary shifter fork and the planetary shift coupler (No. 4, Fig. 3).
3. Remove the attaching cap screws and remove the planetarygear assembly(No. 5, Fig. 3).

NOTE: The planetary gear assembly is dowelled to the transmission housing but can be removed with two screw drivers as shown in Fig. 4.

DISASSEMBLING THE PLANETARY GEAR ASSEMBLY

1. Remove the shim (No. 1, Fig. 24) front cover plate (No. 2, Fig. 24) and rear cover plate (No. 11, Fig. 24).

2. Remove the front ring gear thrust washer (No. 4, Fig. 24) and the rear ring gear thrust washer (No. 10, Fig. 24).

3. Lift out the pinion carrier assembly (No. 9, Fig. 24) as shown in Fig. 37.

4. The pinion gears (No. 6, Fig. 24) may be removed from the pinion carrier assembly by driving out the pinion gear shaft (No. 7, Fig. 24) as shown in Fig. 38.

NOTE: The pinion gears contain a double row of needle bearings. Care must be used when removing the pinion gears that none of these bearings are lost.

ASSEMBLING THE PINION CARRIER ASSEMBLY

1. The pinion gears are replaced into the pinion carrier with a full set of needle bearings in each gear and a thrust washer (Nos. 5, 8, Fig. 24) on each side of the pinion gear.
2. The pinion gear shaft may then be placed into the carrier and driven in with a rawhide mallet. Make sure that the shafts do not extend beyond the machined face of the pinion gear carrier.

NOTE: Do not damage the machined surface of the pinion carrier.

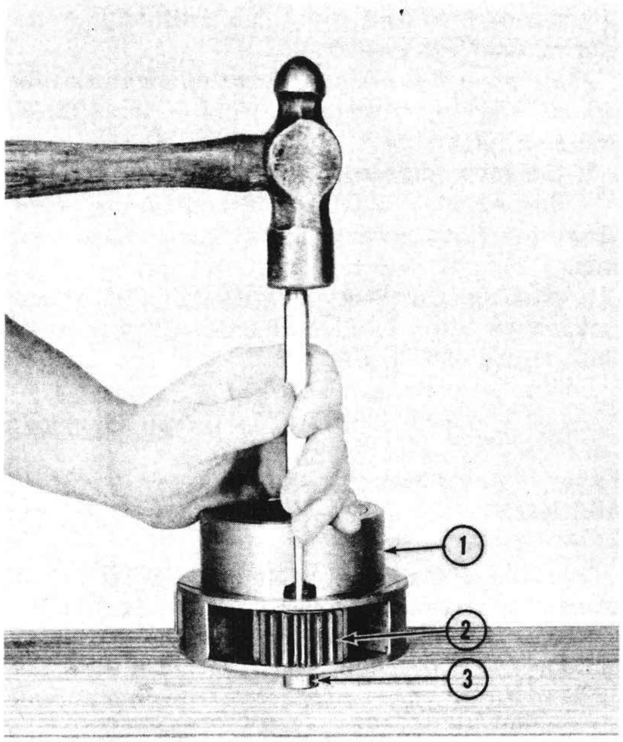


Fig. 38 Removing the Pinion Gears
1. Pinion Carrier 3. Pinion Gear Shaft
2. Pinion Gear

INSTALLING THE PLANETARY GEAR ASSEMBLY

1. Place the front ring gear thrust washer (No. 4, Fig. 24) into the recess on the dowelled side of the planetary ring gear.
2. Place the front ring gear cover (No. 2, Fig. 24) and the front cover shim (No. 1, Fig. 24) over the dowels of the planetary ring gear (No. 3, Fig. 24).

NOTE: The cover plate is turned so that the oil grooves face the bronze thrust washer. The shim is next to the transmission housing.

3. Hold the thrust washer into the recess of the ring gear with the finger tips, and lightly tap the dowelled ring gear into place on the rear of the transmission with a lead or bronze hammer as shown in Fig. 25.

NOTE: The thrust washer must remain in the recess and be free to rotate.

4. Install the pinion carrier assembly (No. 9, Fig. 24) in the ring gear.
5. Install the rear bronze thrust washer (No. 10, Fig. 24) in the recess of the planetary ring gear.
6. Install the ring gear cover (No. 11, Fig. 24) and secure planetary gear assembly to transmission housing with the cap screws.

NOTE: Make sure that the thrust washer is not jarred from the recess in the ring gear while installing the rear cover plate.

TRANSMISSION, DIFFERENTIAL AND HYDRAULIC SYSTEM LUBRICATION

The oil used in the hydraulic system is also used to lubricate the transmission and differential.

Capacity of these combined units is 8 U.S. (6-1/2 Imperial) gallons. Oil specifications are:
S.A.E. 90 for temperatures above 50°F.
S.A.E. 80 for temperatures below 50°F.

Additional oil must be added if the requirements of an external hydraulic system are greater than 1-1/2 gallons. This additional oil must be drained from the housing if the external hydraulic system is disconnected.

SPECIAL TOOLS

The following tools, not normally available at local hardware stores, are required to service the transmission.

1. Two cap screws - 3/8 inch diameter, 16 N.C. thread, with at least 3 inches of thread.
2. Step Plate Number 630-6 from O.T.C. Set Number 630-S
3. Internal and external snap ring pliers.

GROUP II - SECTION B - PART 3

MULTI-POWER TRANSMISSION MF 35-50-65

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DESCRIPTION

The multi-power transmission although similar in design to the Dual Range, incorporates a hydraulically actuated clutch mounted on the input shaft and operated by an externally mounted lever, and an over-running clutch assembly mounted on the forward end of the transmission countershaft.

A control valve mounted on the input shaft retainer and connected to the external lever, provides the method for directing the hydraulic fluid from the hydraulic pump to the hydraulic clutch.

OPERATION

With the lever in the "LOW RANGE POSITION" no hydraulic fluid enters the hydraulic clutch, and the transmission is driven thru the main drive pinion No. 17, Fig. 7, and the countershaft drive gear No. 45.

Movement of the control lever to the "High" position allows the fluid to enter the hydraulic clutch and engages the clutch discs, thus transferring the drive through the input overdrive pinion No. 13 and the countershaft overdrive gear No. 43.

REMOVE TRANSMISSION

With the tractor split between the transmission and engine as outlined in the Individual Engine Section, the transmission may be removed as follows:

1. Drain the lubricant from transmission and differential.

2. Disconnect and remove the step plate from each side of tractor.

3. Remove the muffler and muffler inlet pipe.

4. Disconnect and remove the brake rods and brake pedals. Remove Woodruff key from brake cross shaft and withdraw shaft.

5. Remove the bolts securing the transmission cover. Then with a chain hoist attached to the steering mechanism as shown in Fig. 1, lift cover and steering assembly straight up and away from transmission.

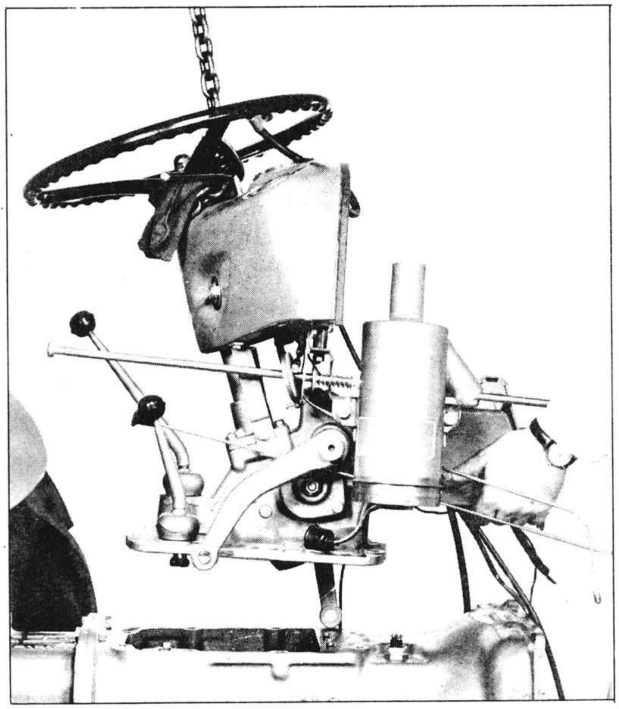

Fig. 1 - Removing or Installing Transmission Cover and Steering Mechanism

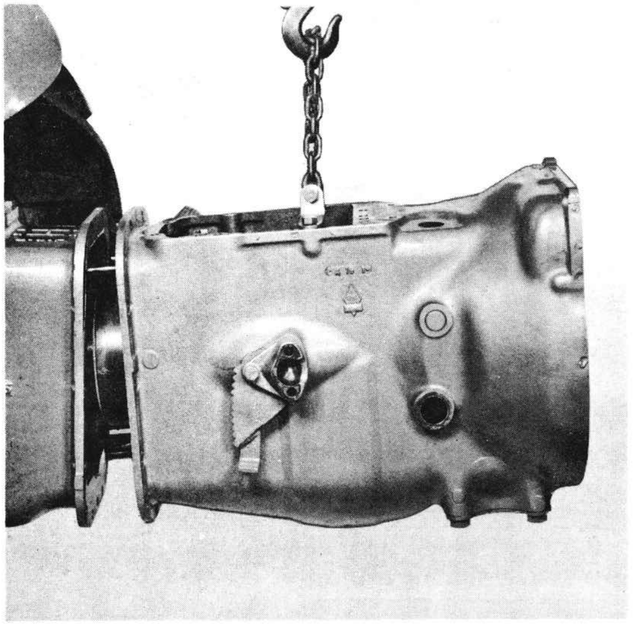

Fig. 2 - Removing or Installing Transmission

6. Remove neutral switch and detent springs. Using a magnetized rod, remove detent balls from the forward end of shifter rails.

7. Disconnect the hydraulic line from the hydraulic pump to the transmission.

8. Place a suitable jack stand under the center housing. With a chain hoist attached to the transmission as shown in Fig. 2, remove bolts securing the transmission. Then move the transmission away from center housing.

DISASSEMBLE TRANSMISSION

1. Refer to Fig. 3 and remove springs No. 1 from clutch release bearing carrier No. 2. Then withdraw carrier and bearing as an assembly.

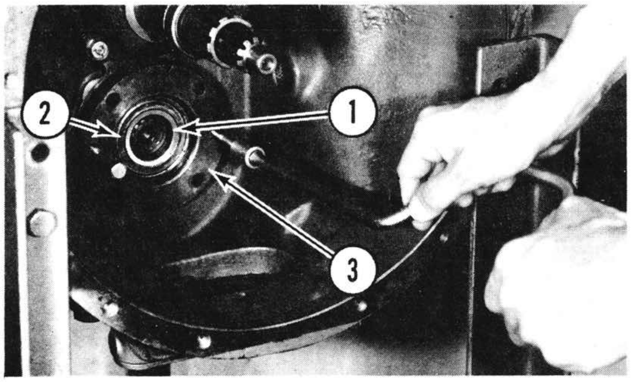

Fig. 4 - Removing PTO Gear Bearing and Bearing Housing
1. Gear - PTO
2. Bearing
3. Housing - Bearing

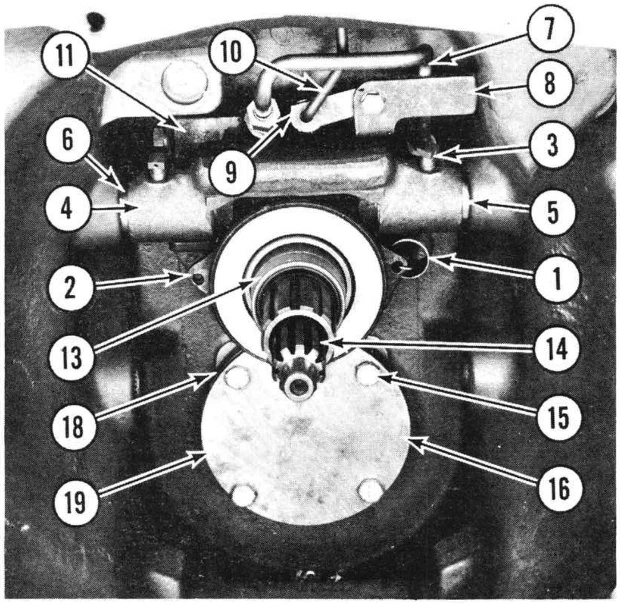

Fig. 3 - Clutch Housing Details and Relative Location of Parts

1. Spring - Release Bearing Return
2. Carrier - Release Bearing
3. Screw - Set
4. Fork - Release Bearing
5. Shaft - Clutch Release
6. Shaft - Clutch Release
7. Line - Oil Inlet
8. Bracket - Valve Shifter Lever
9. Lever - Valve Shifter
10. Rod - Shifter
11. Valve - Oil Control
13. Retainer - Main Input Shaft
14. Shaft - Main Input
15. Bolt - 3/8" x 1-3/8" NC
16. Cover - Housing
18. Housing - Front PTO Bearing
19. Gasket - Housing

2. Remove setscrews No. 3 and withdraw clutch release shafts No. 5 and No. 6 and, release fork No. 4.

Disconnect and remove oil inlet line No. 8.

3. Refer to Fig. 3 and remove bolts securing main drive shaft retainer No. 13. Then remove retainer, valve and valve operating mechanism shown in Fig. 5.

4. Remove bolts No. 15, Fig. 1 and withdraw housing cover No. 16 and cover gasket. Refer to Fig. 3 and remove snap ring No. 31 and spacer No. 32 from forward end of PTO shaft.

5. Refer to Fig. 4 and thread a 3/8" x 4" NC bolt in each of the puller holes in bearing housing No. 3.

Alternately turn bolts and withdraw bearing and housing.

6. Refer to Fig. 6 and remove bolts No. 1 and rail stop plate No. 3.

7. Remove setscrews No. 4 from planetary shift fork No. 5, withdraw shift fork and planetary coupler No. 6.

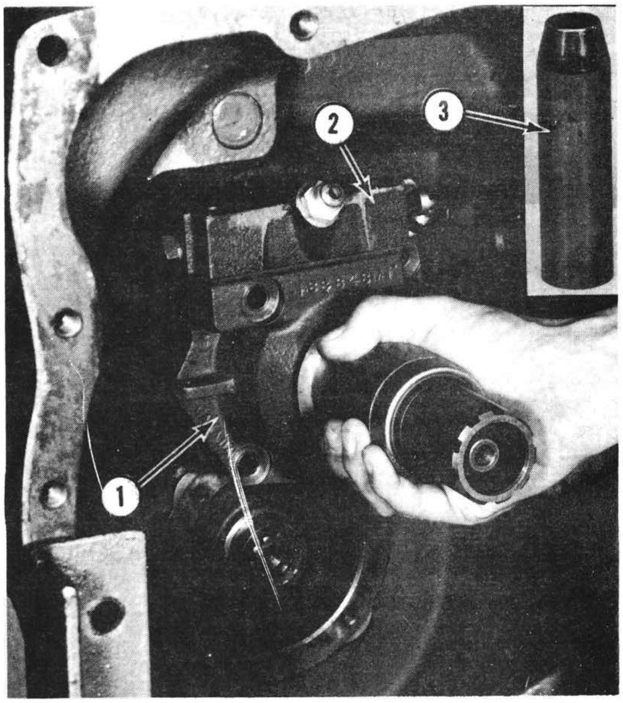

Fig. 5 - Removing or Installing Main Input Shaft Retainer
1. Retainer - Input Shaft
2. Valve - Oil Control
3. Protector - Seal - Tool OTC-FT 357

8. Remove setscrews No. 7 from planetary selector No. 8 and shifter forks No. 12 and No. 14. Withdraw shift rails No. 9, No. 13 and No. 15 and shifter forks No. 12 and No. 14.

9. Remove bolts No. 16 securing planetary gear No. 17. Using two screwdrivers directly opposite, pry the planetary gear away from the transmission housing.

10. Using a long screwdriver against the main shaft inner snap ring No. 1 as shown in Fig. 8, drive main shaft and rear bearing No. 2 out of housing.

11. With gears No. 3 and No. 4 held against the rear of transmission housing as shown in Fig. 9, move the main shaft No. 2 forward to its limits.

Rapidly withdraw shaft allowing the front bearing No. 1 to strike against the gear. Repeat the above operation until the front bearing is forced off main shaft. Withdraw main shaft, gears and bearing from transmission.

12. Refer to Fig. 7 and remove spacer No. 18. Refer to Fig. 10 and remove input shaft No. 1, main drive pinion No. 3, overdrive pinion No. 5 and hydraulic clutch No. 6.

13. Refer to Fig. 7 and remove snap ring No. 33 from forward end of PTO shaft No. 39. Withdraw shaft and PTO gear No. 37.

14. Using a soft hammer, drive countershaft No. 48, Fig. 7, forward just enough to remove snap ring No. 50 at the forward end of countershaft pinion No. 51.

15. Place tool MFN 830, Fig. 11 in position on overdrive gear No. 2 and drive gear No. 3. Tighten bolts finger tight. Remove snap ring No. 40, Fig. 7, from forward end of countershaft.

16. Using a drift, drive countershaft back far enough to lift tool and gear assembly out of transmission.

17. With a soft hammer, drive countershaft forward and out of rear bearing. Withdraw countershaft from forward end of transmission then, remove countershaft pinions No. 51, Fig. 7 and No. 52.

18. If required, refer to Fig. 7 and remove bolt No. 55 and stop No. 57. Withdraw reverse idler shaft No. 58, idler gear No. 63 and thrust washers No. 64.

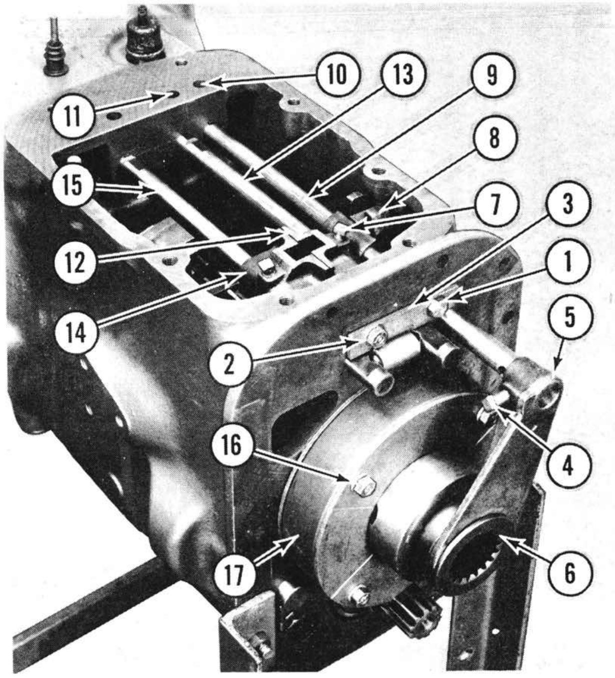

Fig. 6 - Typical Shifter Rails and Planetary Gear Installation
1. Bolt - 3/8 x 7/8 NC
2. Lockwasher
3. Plate - Stop
4. Screw - Set
5. Fork - Planetary Shift
6. Coupler - Planetary
7. Screw - Set
8. Selector - Planetary Shifter Rail
9. Rail - Planetary Shifter
10. Spring - Detent
11. Ball - Detent
12. Fork - Shifter - Low and Reverse
13. Rail - Shifter - Low and Reverse
14. Fork - Shifter - Inter. and High
15. Rail - Shifter - Inter. and High
16. Bolt
17. Gear - Planetary

19. Using a suitable driver, remove bearing No. 53 from lower rear opening of transmission.

INSPECT TRANSMISSION

Wash all parts and transmission housing in a clean solvent and dry with compressed air.

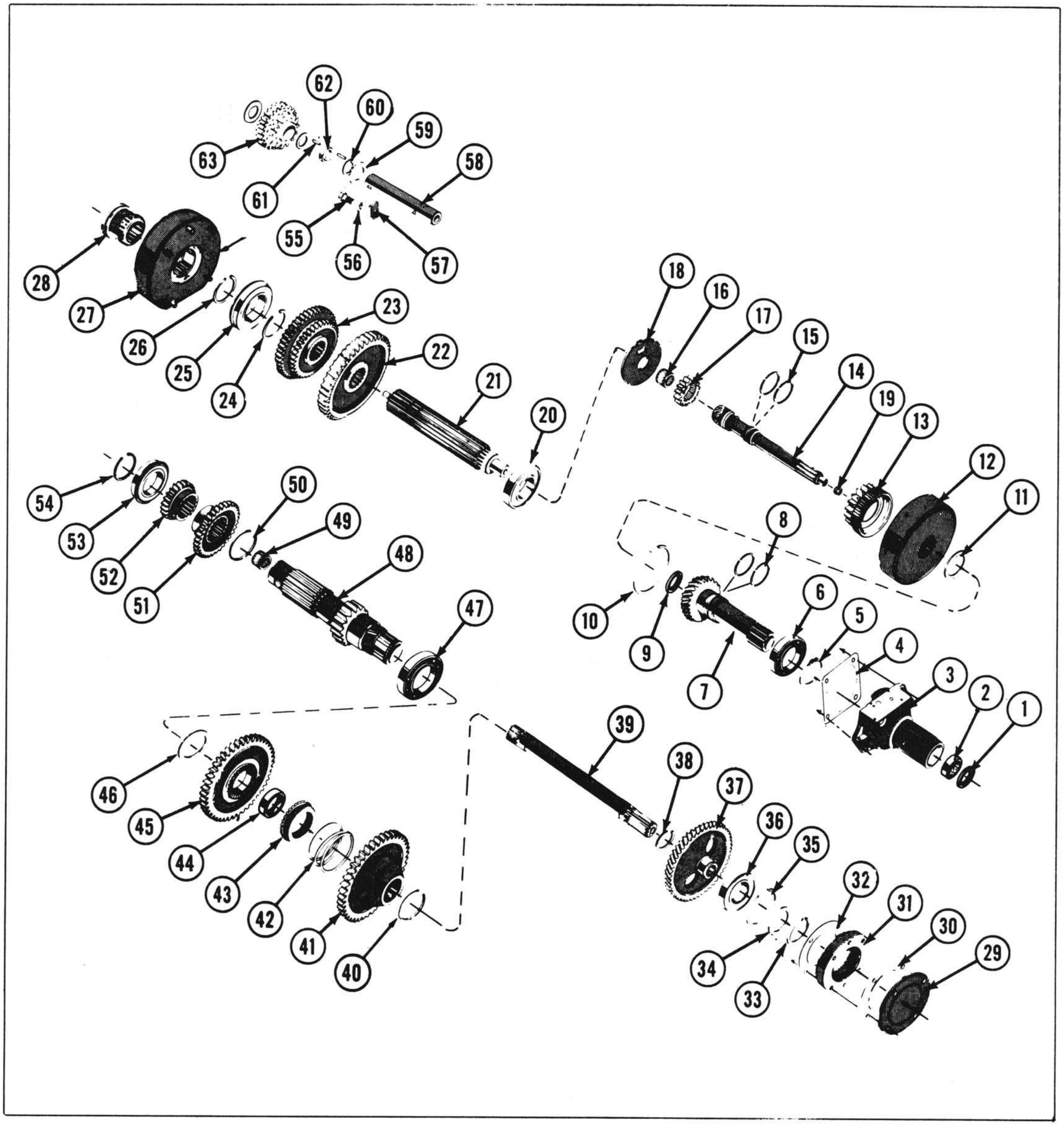

Fig. 7 - Transmission Details and Relative Location of Parts

1. Seal – Retainer Oil
2. Bushing – Retainer
3. Retainer – Main Drive Shaft
4. Gasket
5. Snap Ring
6. Bearing
7. Pinion – PTO
8. Ring – Sealing
9. Seal – Oil
10. Snap Ring
11. Washer – Thrust
12. Clutch Assembly
13. Pinion – Input Overdrive
14. Shaft – Main Drive Input
15. Ring – Sealing
16. Bearing – Needle
17. Pinion – Main Drive
18. Spacer
19. Spacer – Input Shaft
20. Bearing – Ball
21. Shaft – Main
22. Gear – Low
23. Gear – Inter. and High
24. Snap Ring
25. Bearing – Ball
26. Snap Ring
27. Gear – Planetary
28. Coupler – Planetary Shift
29. Cover – Bearing
30. Gasket
31. Housing – Bearing
32. Gasket
33. Snap Ring
34. Spacer
35. Snap Ring
36. Bearing – Ball
37. Gear – PTO Constant Mesh
38. Snap Ring
39. Shaft – PTO Shaft
40. Snap Ring
41. Gear – Overdrive
42. Spring – Clutch Jaw
43. Coupler – Clutch
44. Bushing – Drive Gear
45. Gear – Countershaft Drive
46. Washer – Thrust
47. Bearing
48. Countershaft – Transmission
49. Bearing – Needle
50. Snap Ring
51. Pinion – Countershaft
52. Pinion – Countershaft
53. Bearing
54. Snap Ring
55. Bolt – 3/8" x 7/8 NC
56. Lockwasher
57. Stop – Rev. Idler Gear
58. Shaft – Reverse Gear
59. Washer – Thrust
60. Washer – Flat
61. Bearing – Needle
62. Spacer
63. Gear – Reverse Idler

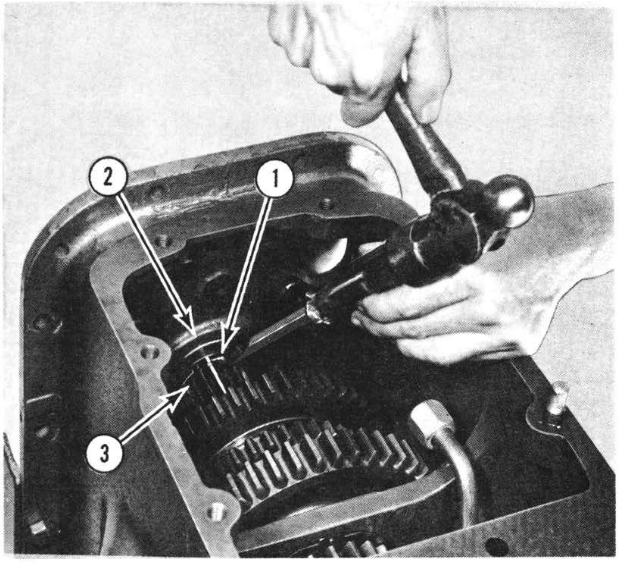

Fig. 8 - Removing Main Shaft and Rear Bearing from Housing
1. Snap Ring 2. Bearing – Main Shaft – Rear 3. Shaft – Main

NOTE: Do not wipe parts or inside of transmission housing with a material that leaves lint.

1. Inspect all gears for chipped or broken teeth and replace those where either condition is present.

2. Check all bearings for bind or rough spots. If either condition is noted a new bearing must be installed.

3. Inspect all shafts for excessively worn or damaged splines. Replace shaft where either condition is present.

4. Inspect the bushings in the countershaft drive gear No. 41 and forward end of input shaft retainer No. 3.

5. Inspect all thrust washers and replace those that are worn or scored.

6. Check the needle bearings in the input shaft and reverse idler gear. Replace bearings if worn or damaged.

7. Refer to Fig. 7 and remove and discard sealing rings No. 8 and No. 14.

DISASSEMBLE INPUT SHAFT RETAINER

1. Remove control valve from retainer No. 2, Fig. 13. Remove snap ring No. 8 and withdraw PTO pinion No. 5.

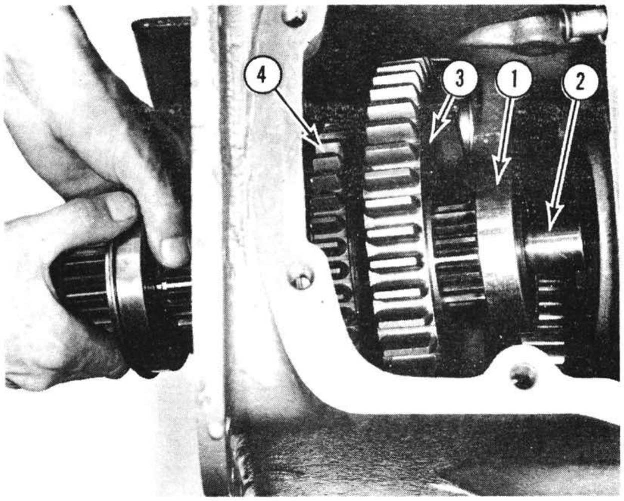

Fig. 9 - Moving Front Bearing from Main Shaft
1. Bearing – Main Shaft Front 3. Gear – Low
2. Shaft – Main Shaft 4. Gear – Intermediate and High

2. Remove and discard pinion sealing rings No. 6.

3. Using tool MFN 850 as shown in Fig. 14, drive oil seal out of pinion.

4. If required, remove snap ring No. 4, Fig. 13 and with bearing supported on bed of press, press bearing No. 7 from pinion.

5. Using a sharp chisel, drive seal off forward end of retainer.

INSPECT INPUT SHAFT RETAINER

1. Inspect bearing for bind or rough spots and replace if either condition exists.

2. Check pinion for damage or excessive wear at gear teeth and splines. Replace pinion if either condition is noted.

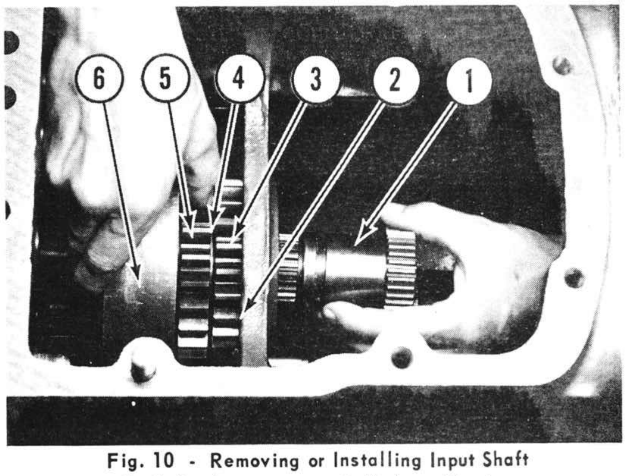

Fig. 10 - Removing or Installing Input Shaft
1. Shaft – Input 4. Washer – Thrust
2. Spacer – Input Shaft 5. Pinion – Overdrive
3. Pinion – Main Drive 6. Clutch – Hydraulic

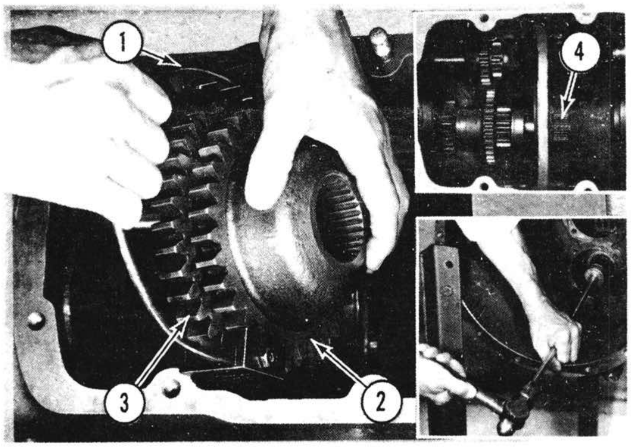

Fig. 11 - Removing or Installing Overdrive and Countershaft Drive Gear Assembly

1. Holder – Gear – Tool MFN 830
2. Gear – Overdrive
3. Gear – Countershaft – Drive
4. Countershaft

ASSEMBLE INPUT SHAFT RETAINER

1. If removed, start bearing No. 7, Fig. 13 over forward end of pinion. Support bearing on bed of press and press pinion into bearing. Install snap ring No. 4.

2. Place new sealing rings No. 6 on pinion.

3. Refer to Fig. 15 and place a new seal No. 3 over end of installer, tool MFN 849, with the lettered end down, then carefully drive in pinion and against shoulder.

4. Start pinion No. 5, Fig. 13 in retainer. Using a soft hammer, drive pinion and bearing into position and install snap ring No. 8

5. Refer to Fig. 16 and place seal guide No. 3, tool MFN 848-B in seal installer No. 2. Place oil seal No. 4 on installer with the sealing portion up. Start seal over forward end of retainer and carefully drive into position.

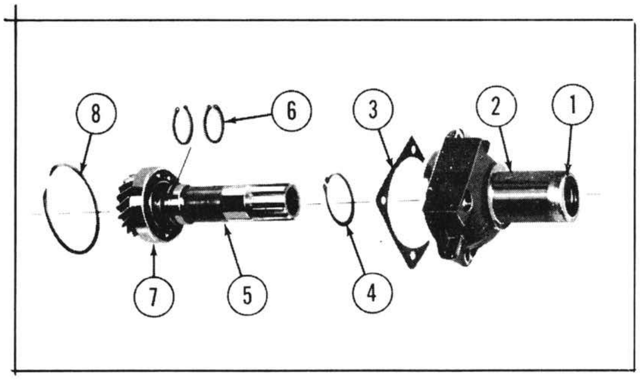

Fig. 13 - Input Shaft Retainer Details and Relative Location of Parts

1. Seal – Oil
2. Retainer – Input Drive Shaft
3. Gasket
4. Snap Ring
5. Pinion – PTO
6. Ring – Sealing
7. Bearing
8. Snap Ring

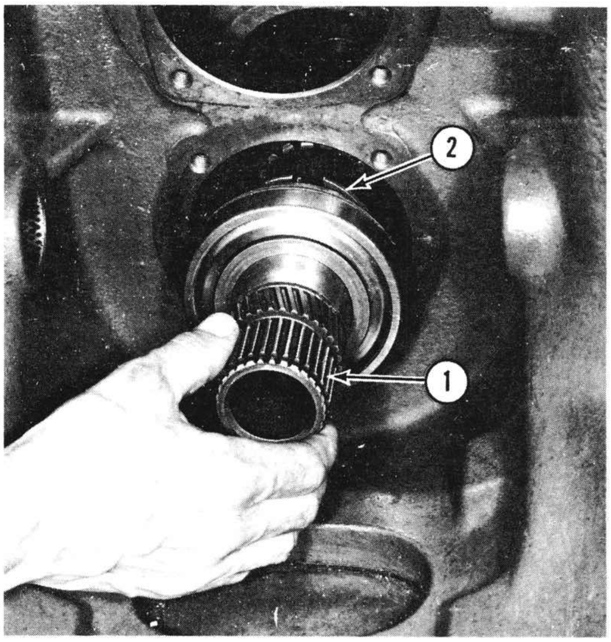

Fig. 12 - Removing or Installing Transmission Countershaft

1. Countershaft 2. Bearing – Countershaft

DISASSEMBLE HYDRAULIC CLUTCH

1. Refer to Fig. 18 and remove snap ring No. 9 from clutch housing.

2. Remove clutch retaining plate No. 8, piston return springs No. 7, clutch discs No. 6 and plates No. 5.

3. Allow the clutch housing No. 1 to be dropped on bench several times with the open end down and jar the piston out of housing.

4. Remove and discard sealing rings No. 2 and No. 3 from piston and inner hub of housing.

INSPECT HYDRAULIC CLUTCH

Wash all parts in a clean solvent and dry with compressed air.

> *NOTE: Do not wipe parts with a material that leaves lint particles.*

1. Inspect the clutch discs for damage, scoring or excessive wear and replace if any of the above conditions are noted.

2. Check the clutch plates for damage or score marks. Light score marks may be dressed off with crocus clutch.

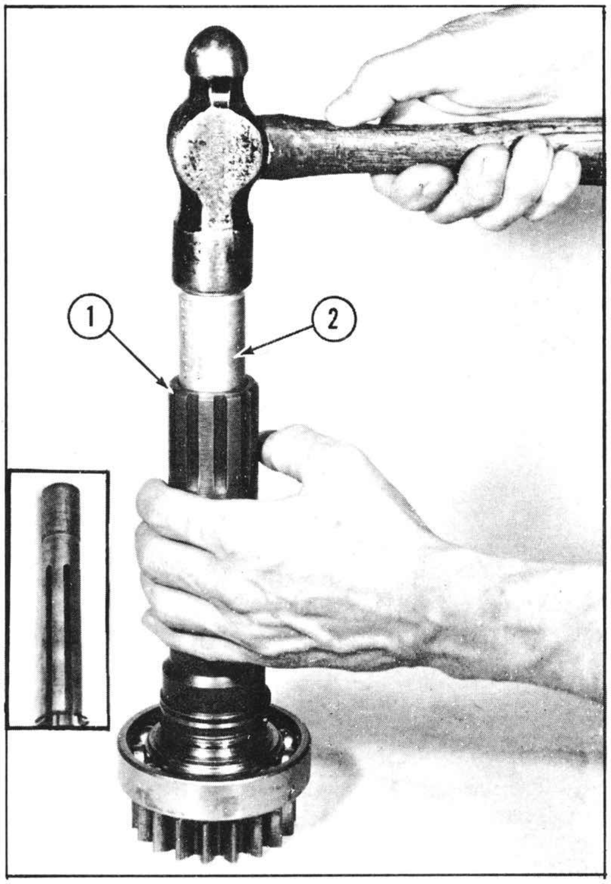

Fig. 14 - Removing Oil Seal from PTO Pinion
1. Pinion – PTO 2. Remover – Seal – Tool MFN 850

ASSEMBLE HYDRAULIC CLUTCH

1. Refer to Fig. 18 and place a new sealing ring No. 2 on inner hub of clutch housing. Install a new sealing ring No. 3 on clutch piston No. 4.

2. Start clutch piston in housing with the hub end up. Using a small screwdriver, move the sealing ring into its groove and the piston into the housing.

3. Place clutch plate No. 3, Fig. 19 in housing with the tangs registering in one serration off the oil inlet hole. Place clutch disc No. 3 in position on plate.

4. Install the remaining clutch plates and discs in sequence with the tangs on the clutch plates staggered.

5. Place a clutch return spring No. 7, Fig. 18 in position on each tang of the lower clutch plate.

6. Place clutch retaining plate in housing. Support housing on bed of press and apply just enough pressure to permit the installation of snap ring No. 9.

DISASSEMBLE PLANETARY GEAR

1. Refer to Fig. 21 and support planetary carrier No. 1 on bed of press. Press shaft No. 2 out of pinion No. 3 and carrier.

2. Remove gear, bearings, spacers and thrust washers.

3. Remove the remaining planetary gears as outlined above.

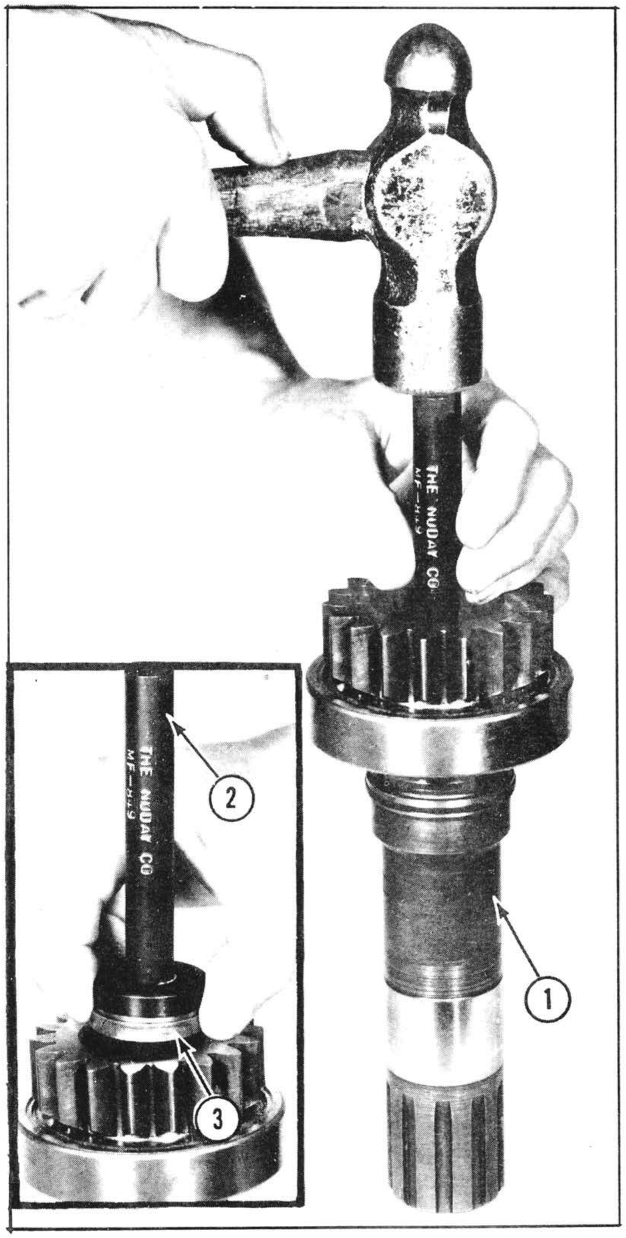

Fig. 15 - Installing PTO Pinion Oil Seal
1. Pinion – PTO 2. Installer – Seal – Tool MFN 849
3. Seal – Oil

INSPECT PLANETARY GEAR

1. Inspect the gears for chipped or broken teeth and replace if either condition is present.

2. Check the needle bearings and thrust washers for excessive wear. Replace those parts where either condition is noted.

ASSEMBLE PLANETARY GEAR

1. Place a coating of grease to one side of each thrust washer No. 6, Fig. 20, and a coating to needle bearings No. 9, spacers No. 8.

2. Place a thrust washer No. 6 on bench with the side having the grease up. Place planetary pinion No. 7 on thrust washer.

3. Insert spacer No. 8 in planetary pinion. Place the first row of needle bearings around the inside diameter of pinion.

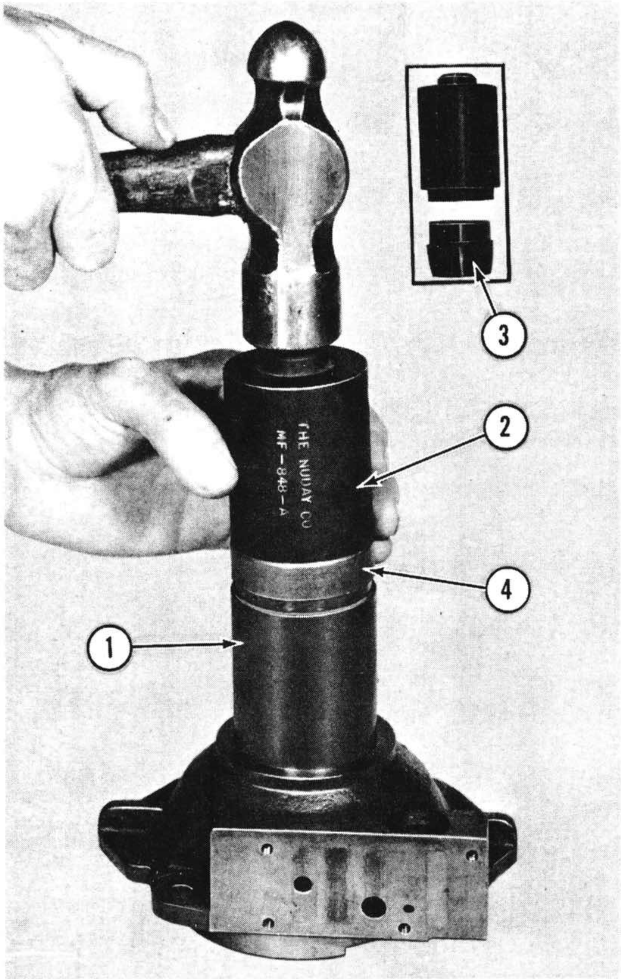

Fig. 16 - Installing Retainer Oil Seal
1. Retainer – Input Shaft
2. Installer – Seal – Tool MFN 848-A
3. Guide – Seal – Tool MFN 848-B
4. Seal – Oil

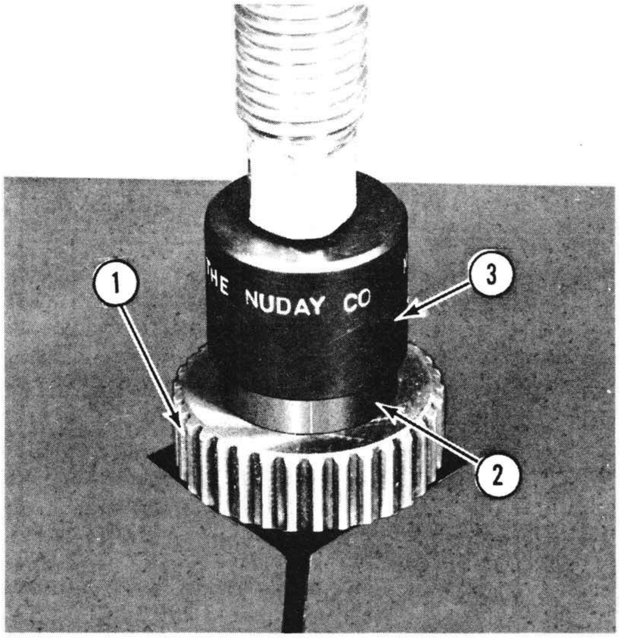

Fig. 17 - Installing Input Shaft Bearing
1. Shaft – Input 2. Bearing – Needle
3. Installer – Tool MFN 216

4. Insert center spacer No. 8 followed by the second row of needle bearings. Place third spacer in position on upper row of bearings followed by second thrust washer.

5. Place pinion and thrust washer assembly in position in planetary carrier.

6. Support carrier on bed of press with the hub end down. Then carefully press shaft into position.

ASSEMBLE TRANSMISSION

1. If removed, refer to Fig. 7 and apply a coating of grease to one side of each thrust washer No. 59 and the inside diameter of the idler gear No. 63.

Place thrust washer on bench with the coated side up. Then position idler gear on thrust washer. Insert a dummy shaft .312" x 1-7/8" through idler gear.

Insert flat washer No. 60 over shaft and into gear. Install the first row of needle bearings No. 61 in gear followed by spacer No. 62. Assemble the second row of bearings in gear followed by second flat washer No. 60 and thrust washer No. 59.

Place idler gear assembly in transmission with the smaller gear diameter forward. Then

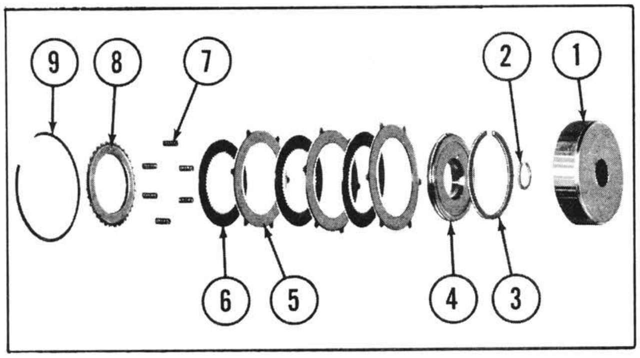

Fig. 18 - Clutch Details and Relative Location of Parts
1. Housing – Clutch
2. Ring – Piston
3. Ring – Piston
4. Piston – Clutch
5. Plate – Clutch
6. Disc – Clutch
7. Spring – Piston Return
8. Plate – Clutch Retaining
9. Snap Ring

carefully install idler gear shaft No. 58 through rear transmission opening and into idler gear. Secure shaft with stop No. 57 and bolt No. 55.

2. If removed, refer to Fig. 7 and place snap ring No. 50 over countershaft No. 48 and allow it to float free at the undercut position of shaft.

3. Refer to Fig. 12 and start countershaft No. 1 in lower front opening of transmission.

Place forward countershaft pinion No. 7, Fig. 22 over countershaft with the hub end to the rear followed by countershaft pinion No. 5 with the hub end forward.

4. Refer to Fig. 7 and place thrust washer No. 46 over forward end of countershaft No. 48.

5. Move countershaft No. 4, Fig. 11, back just far enough and place gear assembly No. 2 and No. 3 over forward end of countershaft.

Rotate countershaft and gears slightly to the left and right to achieve full shaft engagement. Refer to Fig. 22 and install snap ring No. 11 over forward end of countershaft.

6. Move countershaft forward and pinions No. 5 and No. 7, Fig. 22 back. Install snap ring No. 23 in groove of countershaft.

7. Refer to Fig. 22 and place PTO gear No. 12 in position with the hub end forward. Insert PTO shaft No. 24 through countershaft and PTO gear.

Refer to Fig. 7 and place a new gasket No. 32 on bearing housing No. 31. Using two 3/8" x 7/8" NC bolts, attach bearing housing to the front lower opening of transmission as shown in Fig. 3.

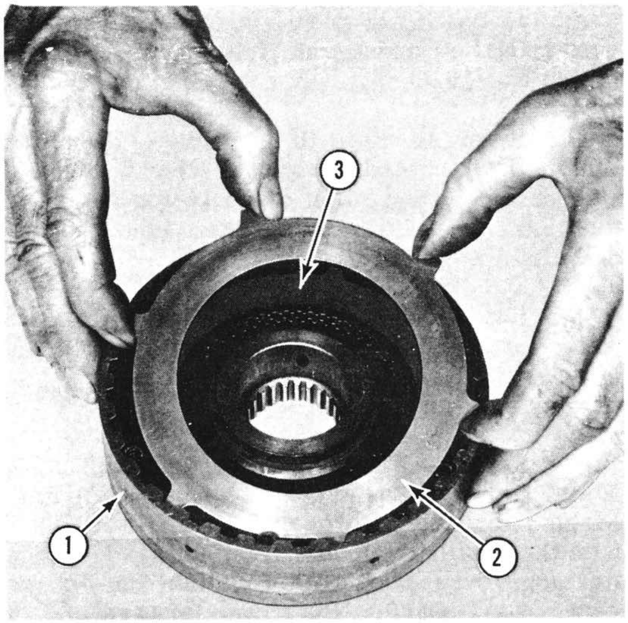

Fig. 19 - Removing or Installing Clutch Disc
1. Housing – Clutch 2. Plate – Clutch 3. Disc – Clutch

8. With the PTO shaft fully engaged with the PTO gear, drive hub of gear into front bearing.

Refer to Fig. 7 and install thrust washer No. 34 and snap ring No. 33. Install housing cover No. 29 with a new gasket No. 30.

9. Start bearing No. 53 over end of countershaft then, with a wood block between PTO gear and overdrive gear, drive rear countershaft bearing into position.

10. Refer to Fig. 7 and engage splines of overdrive pinion No. 13 in hydraulic clutch.

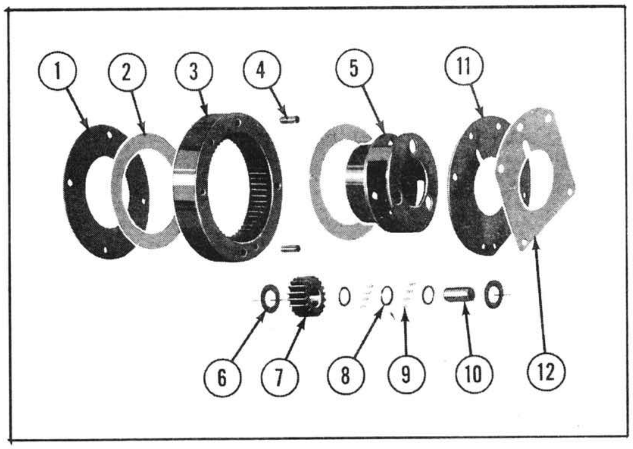

Fig. 20 - Planetary Gear Details and Relative Location of Parts
1. Cover – Ring Gear
2. Washer – Thrust
3. Gear – Planetary Ring
4. Pin – Dowel
5. Carrier – Planetary
6. Washer – Thrust
7. Pinion – Planetary
8. Spacer
9. Bearing -- Needle
10. Shaft – Pinion
11. Cover – Ring Gear
12. Shim – Cover Shim

Apply a coating of grease to one side of thrust washer No. 17 and attach it to input overdrive pinion No. 13.

11. Refer to Fig. 10 and place hydraulic clutch No 6, overdrive pinion No. 5, thrust washer No. 4 and main drive pinion No. 3 in position. Then insert input shaft through gear and clutch assembly.

12. Refer to Fig. 7 and place spacer No. 18 in the forward side of center opening with the offset to the front. Move clutch and gear assembly back and against spacer.

13. Refer to Fig. 9, and insert main shaft No. 2 through upper transmission opening. Place inter and high gear No. 4, over shaft with the smaller gear diameter forward. Place low gear over shaft with the hub end to the rear. Start bearing No. 1 over forward end of shaft.

14. Refer to Fig. 23 and place tool, MFN-458 in back side of upper center opening. Start forward end of main shaft through tool, then using a soft hammer, drive main shaft into bearing. Move main shaft back and remove tool.

15. Start front main bearing into center opening then, with the input shaft properly aligned, drive main shaft and bearing into position.

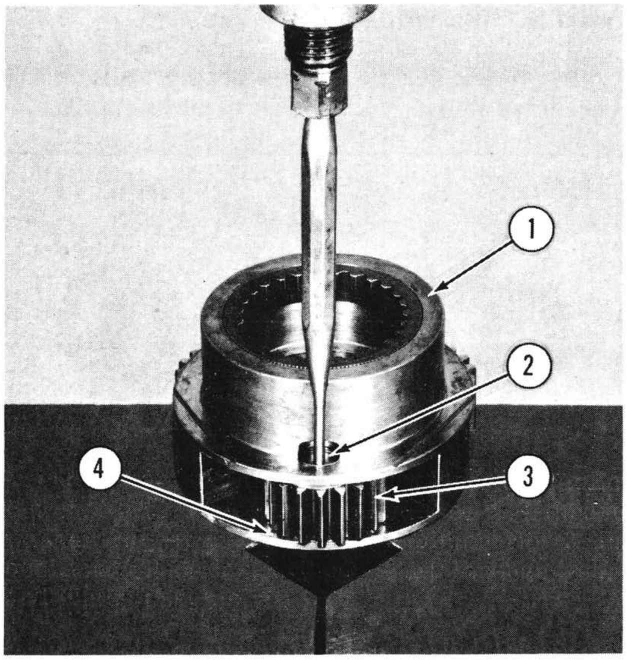

Fig. 21 - Removing Planetary Pinion Shaft

1. Carrier
2. Shaft – Pinion
3. Pinion – Planetary
4. Washer – Thrust

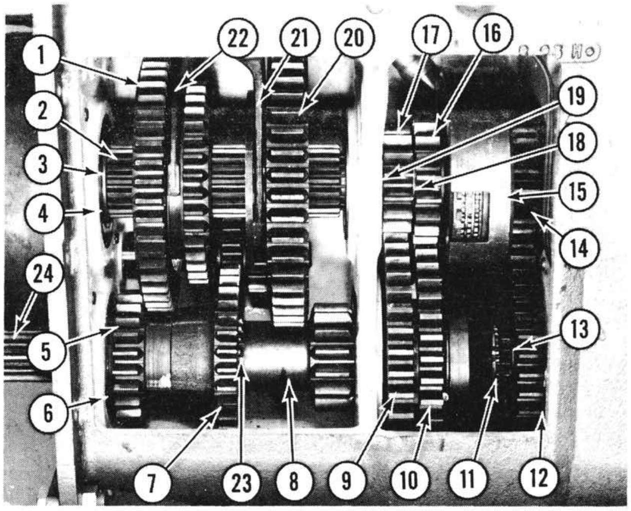

Fig. 22 - Cutaway View of Multi-Power Transmission

1. Gear – Inter and High
2. Shaft – Main
3. Snap Ring
4. Bearing – Main Shaft
5. Pinion – Countershaft
6. Bearing – Countershaft
7. Pinion – Countershaft
8. Shaft – Countershaft
9. Gear – Countershaft
10. Gear – Overdrive
11. Snap Ring
12. Gear – PTO Constant Mesh
13. Snap Ring
14. Pinion – PTO
15. Clutch – Hydraulic
16. Pinion – Overdrive
17. Pinion – Main Drive
18. Washer – Thrust
19. Spacer
20. Gear – Low
21. Fork – Shifter
22. Fork – Shifter
23. Snap Ring
24. Shaft – PTO
25. Bearing – Main Shaft Front

16. Refer to Fig. 5 and using a new gasket attach oil control valve No. 2 to input shaft retainer No. 1 with the bolt having the copper washer installed in front right opening.

17. Refer to Fig. 7 and install new sealing rings No. 15 on input shaft No. 14. Place thrust washer No. 11 over input shaft with the bronze side toward the front.

18. Refer to Fig. 5 and place seal protector FT 357 over forward end of input shaft. Using a new gasket install input shaft retainer.

19. Refer to Fig. 3 and install lever bracket No. 8, lever No. 9, shifter rod No. 10 and secure with bolts. Install oil inlet line No. 7.

20. Place release bearing fork No. 4 in position and install clutch release shafts No. 5 and No. 6. Tighten setscrews No. 3, and install lockwire.

21. Apply a light coating of lubriplate over splines of PTO pinion. Install clutch release bearing and carrier No. 21 over pinion and secure with return springs No. 1.

22. Refer to Fig. 20 and place thrust washer No. 2 in the doweled side of planetary gear No. 3. Place cover No. 11, over dowels followed by shim No. 12.

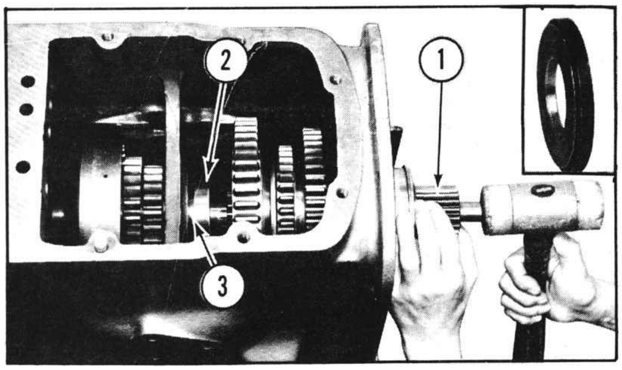

Fig. 23 - Installing Bearing on Main Shaft
1. Shaft – Main 2. Bearing – Ball
3. Installer – Bearing – Tool MFN-458

23. Refer to Fig. 6 and place planetary ring gear in position with the dowels registering in transmission housing.

> *NOTE: Check to be certain that the thrust washer remains in its proper position.*

24. Install planetary gear No. 5, Fig. 20 in ring gear No. 3 followed by outer washer. Install outer cover No. 1 and secure with bolts.

25. Refer to Fig. 6 and start planetary shift rail No. 9 in transmission. Start selector No. 8 over forward end of shift rail and move rail forward to its limit. Position selector and tighten setscrew.

Place shift fork No. 5 in coupler No. 6 and over shift rail No. 9. Tighten setscrew.

26. Place shifter fork No. 12, in groove of low gear No. 20, Fig. 7 and install shifter rail No. 13. Tighten setscrew.

Place shifter fork No. 14, Fig. 6 in groove of inter and high gear. Install shifter rail No. 15 and tighten setscrew. Secure setscrews with lockwire.

Install stop plate No. 3 and secure with bolts No. 2.

INSTALL TRANSMISSION

1. Apply a new gasket to the mounting surface of center housing.

2. With the transmission supported on a chain hoist as shown in Fig. 2, align the transmission with the center housing. Move transmission into position and secure with nuts and bolts. Tighten bolts to their specified torque.

3. Insert a detent ball in the transmission opening at the forward end of each shifter rail followed by a detent spring. Install neutral switch.

4. Apply a new transmission cover gasket. Refer to Fig. 1 and install cover on transmission being certain the shift levers are properly engaged. Install cover bolts and tighten to their specified torque.

5. Install brake cross shaft and insert Woodruff key in keyway. Install brake pedals and brake rods.

6. Install muffler, muffler inlet pipe and the step plates.

7. Fill the transmission with 8 US gallons (6-1/2 Imp. Gallons) of S.A.E. 80 mineral oil.

8. Reassemble the remaining portion of tractor as outlined under Individual Engine Section.

PART 2. DIFFERENTIAL, PINION AND REAR AXLE
MF 65 TRACTOR

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The power input from the transmission main drive shaft is transmitted through the rear drive shaft and shear coupling to a spiral bevel driving pinion and ring gear. The power is then transmitted through the differential unit and the planetary gear assemblies for an overall reduction of 10.9:1.

REMOVING THE DIFFERENTIAL CENTER HOUSING

1. Drain the oil from the differential housing and transmission.

2. Support the tractor with floor jacks under the transmission and the differential center housing.

3. Drive wooden wedges in between the front axle beam and the front axle support on both sides of the tractor.

4. Disconnect and remove:

a. Step boards from both sides of the tractor.

b. Brake rods (at the rear clevis) and brake lever springs.

c. The exhaust pipe.

d. The clutch pedal pivot assembly from the PTO shifter lever cover. Remove the cover assembly.

e. The clutch shaft arm clevis pin from the rod. Remove the clutch pedal and clutch pedal pull-rod.

f. The bolts securing the transmission housing to the differential center housing. Push the rear axle assembly to the rear.

5. Place the differential housing on a stand or block up securely.

DISASSEMBLING THE DIFFERENTIAL CENTER HOUSING

The center housing must first be separated from the transmission as outlined in "Removing the Differential Center Housing". To disassemble the center housing without separating it from the tractor, remove the hydraulic lift cover, hydraulic pump, rear drive shaft and coupler. See Group III, Section A, Part 1. The differential center housing may then be disassembled through the lift cover opening.

To remove the axle shafts, housing, differential, etc., it is necessary to remove some external assemblies and connections. See "Removing the Differential Center Housing".

REAR AXLE SHAFTS

The axle shafts are forged alloy steel. Their inner ends are splined into the differential gears; the outer ends are supported by tapered roller bearings.

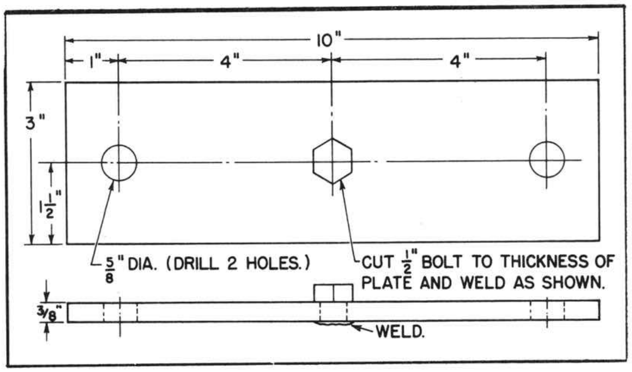
10"
1"
4"
4"
3"
$1\frac{1}{2}$"
$\frac{5}{8}$" DIA. (DRILL 2 HOLES.)
CUT $\frac{1}{2}$" BOLT TO THICKNESS OF PLATE AND WELD AS SHOWN.
3/8"
WELD.

Fig. 1 - Rear Axle Preload Tool

The inner splined ends carry the brake discs. These are housed in sealed compartments between the differential carrier plates and the axle housings. See Group IV, Section B, Part 2, for Brake and Wheel Assembly information.

The outer end of the splined shaft meshes with the planetary pinion gears. As the pinion gears rotate, the carrier also rotates. The wheel axle assembly is splined to the pinion carrier.

These planetary units operate in enclosed oil baths.

SERVICING THE REAR AXLE SHAFT AND HOUSING

ADJUSTING REAR AXLE END-PLAY

The rear axle of the MF 65 tractor is preloaded to give 0.001 to 0.005 inch. The tool shown in Fig. 1 permits an easy check for correct pre-load.

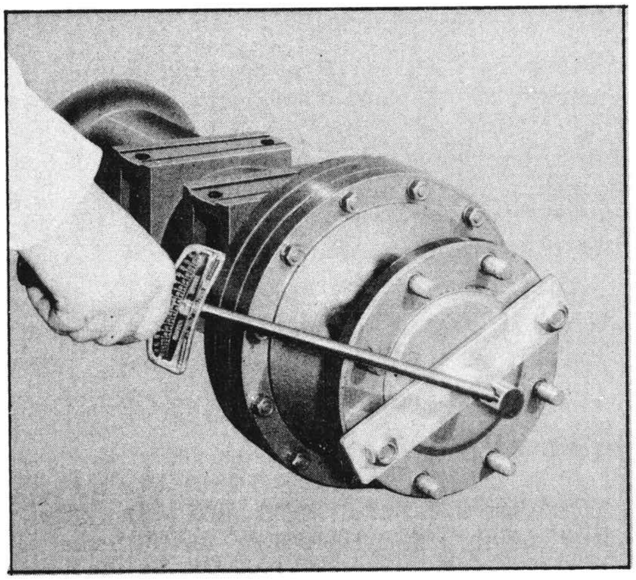

Fig. 2 - Checking Rear Axle Preload

Remove the axle shaft and housing from the differential center housing (see below) and install the tool as shown in Fig. 2. With a torque wrench on the center nut, it should require 5 to 10 ft.-lbs. indicated torque to turn the axle. If less torque than this is required, shims must be added. If more torque is required, shims must be removed.

If this check shows that the preload is incorrect, determine how many shims to add or remove as follows:

1. Attach a dial indicator to the axle housing as shown in Fig. 3. Have the point ride against the face of the wheel axle.

2. Use two screwdrivers, 180°apart, to check the end-play of the wheel axle. Record this figure.

3. Add to the present shim pack, shims equal to the total end-play indicated plus 0.005 inch.

4. As a final check, assemble the wheel axle and again check the torque required to turn the axle.

REMOVING THE REAR AXLE SHAFT AND HOUSING AS A UNIT

1. Drain the planetary hub, transmission and differential center housing.

2. Jack up the tractor under the differential center housing. Remove the fender and wheel.

3. Disconnect the lower link from the lower link shaft and the brake rod at the rear clevis.

4. Support the axle housing and remove the nuts attaching it to the differential center housing.

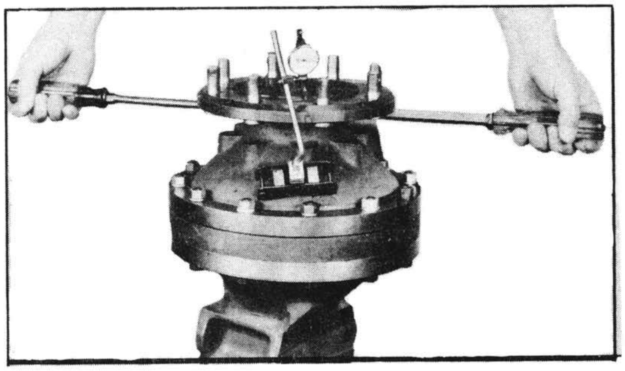

Fig. 3 - Checking Rear Axle End-Play

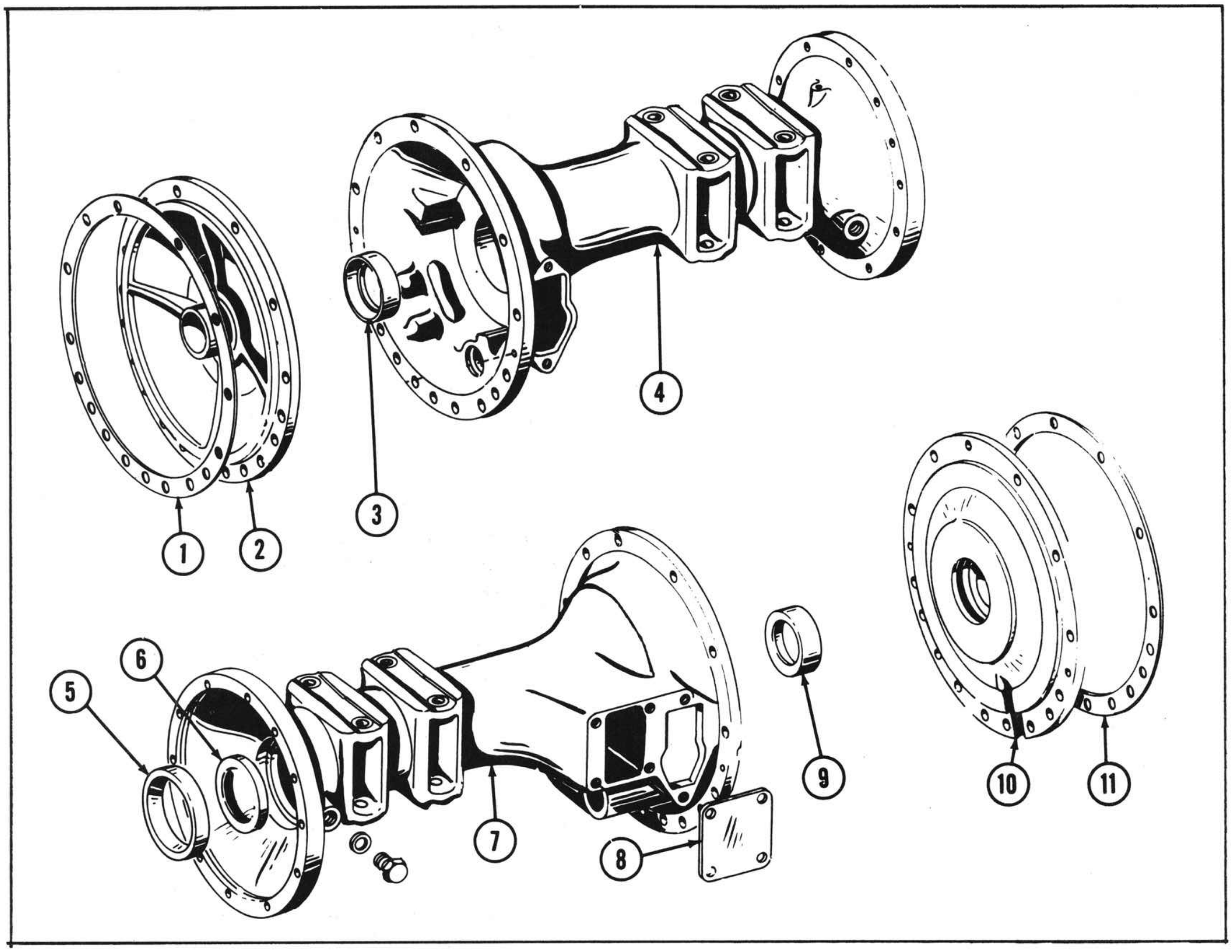

Fig. 4 - Rear Axle Housing Assemblies

1. Gasket
2. Differential Carrier Plate
3. Oil Seal
4. Left-Hand Axle Housing
5. Bearing Cup
6. Oil Seal
7. Right-Hand Axle Housing
8. Lock Assembly Cover Plate
9. Oil Seal
10. Differential Carrier Plate
11. Gasket

5. Remove the axle housing, shown in Fig. 4, and shaft as a unit.

REMOVING THE REAR AXLE SHAFT ONLY

1. Drain the differential center housing, transmission and planetary hub.

2. Jack up one side of the tractor and remove the wheel.

3. Remove the bolts attaching the planetary hub to the axle housing and remove the planetary hub.

> *NOTE: Always wedge the differential lock and the brakes in the engaged position before removing the axle shaft.*

4. Carefully remove the axle shaft from the housing.

DISASSEMBLING THE AXLE HOUSING AND SHAFT ASSEMBLY

Remove the following:

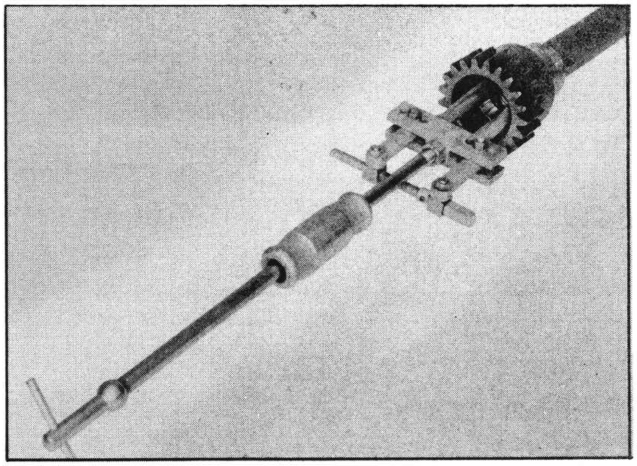

Fig. 5 - Removing Axle Bearing Cup

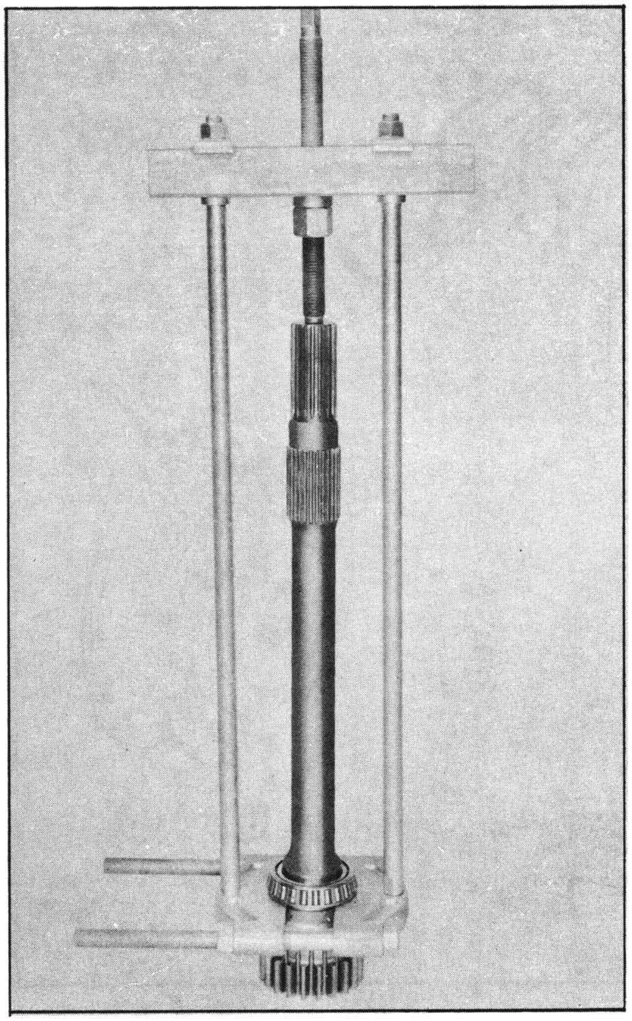

Fig. 6 - Removing Axle Tapered Bearing

1. The axle shaft bearing cup as shown in Fig. 5.

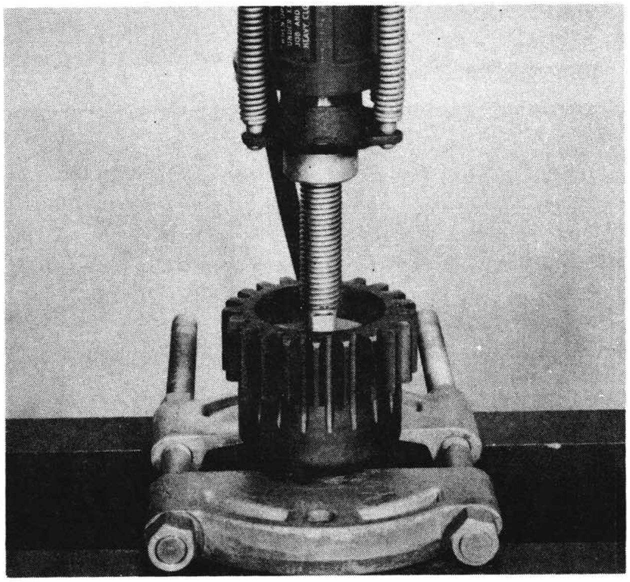

Fig. 7 - Installing Axle Bearing Cup

2. The axle shaft tapered bearing as shown in Fig. 6.

3. The oil seals from the ends of the axle housing.

4. The bearing cup from the wheel end of the axle housing.

ASSEMBLING THE AXLE HOUSING AND SHAFT ASSEMBLY

The housing is in place and the brakes and differential lock are wedged in the engaged position.

1. Install the axle shaft bearing cup with a step plate and arbor press as shown in Fig. 7. Lubricate the outside diameter of the bearing cup and the inside diameter of the shaft end.

NOTE: Press the cup in until it bottoms.

2. With the axle shaft mounted in an arbor press, install the tapered bearing as shown in Fig. 8. Lubricate the shaft and the inside diameter of the bearing.

NOTE: Press the bearing until it bottoms against the shoulder (No. 1, Fig. 9) on the axle shaft.

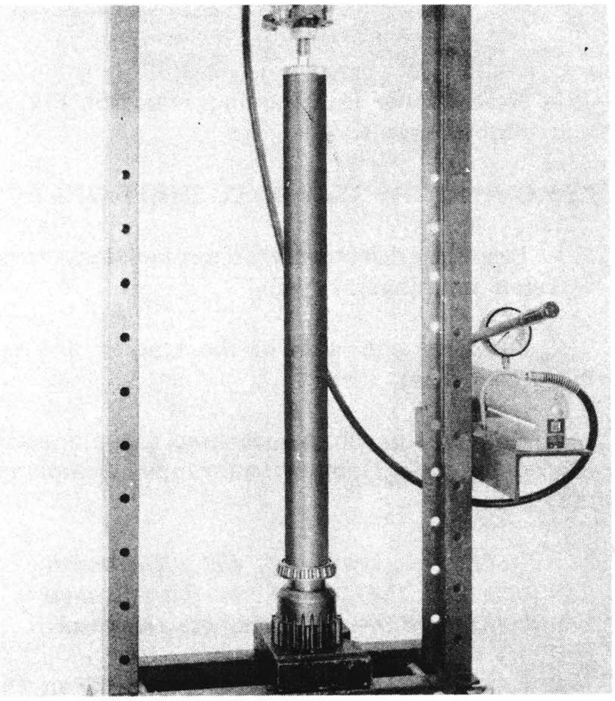

Fig. 8 - Installing Axle Tapered Bearing

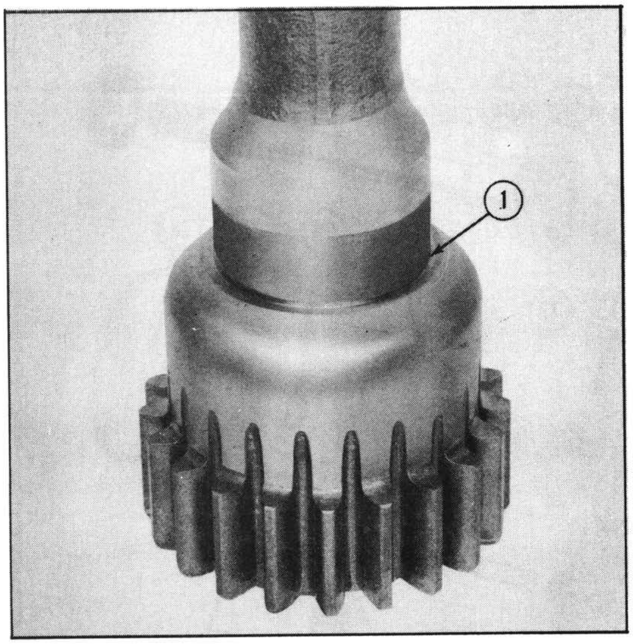

Fig. 9 - Axle Shaft End
1. Shoulder

3. Install the following:

a. The oil seals on each end of the axle housing.

NOTE: Apply gasket sealing compound between the oil seal and its bore.

b. The bearing cup in the wheel end of the axle housing.

NOTE: The oil seal in the wheel end of the axle housing may be replaced without disturbing the bearing cup.

DETERMINING THE AXLE SHAFT END-PLAY AND INSTALLING THE AXLE SHAFT

Install the following:

1. The axle shaft. (Align the splines with the brake discs and use care when entering the oil seal in the differential carrier plate).

NOTE: Be sure that the differential lock and brakes are in the engaged position when installing the axle shaft. Release them after the axle shaft has been installed.

2. The planetary pinion carrier and snap ring.

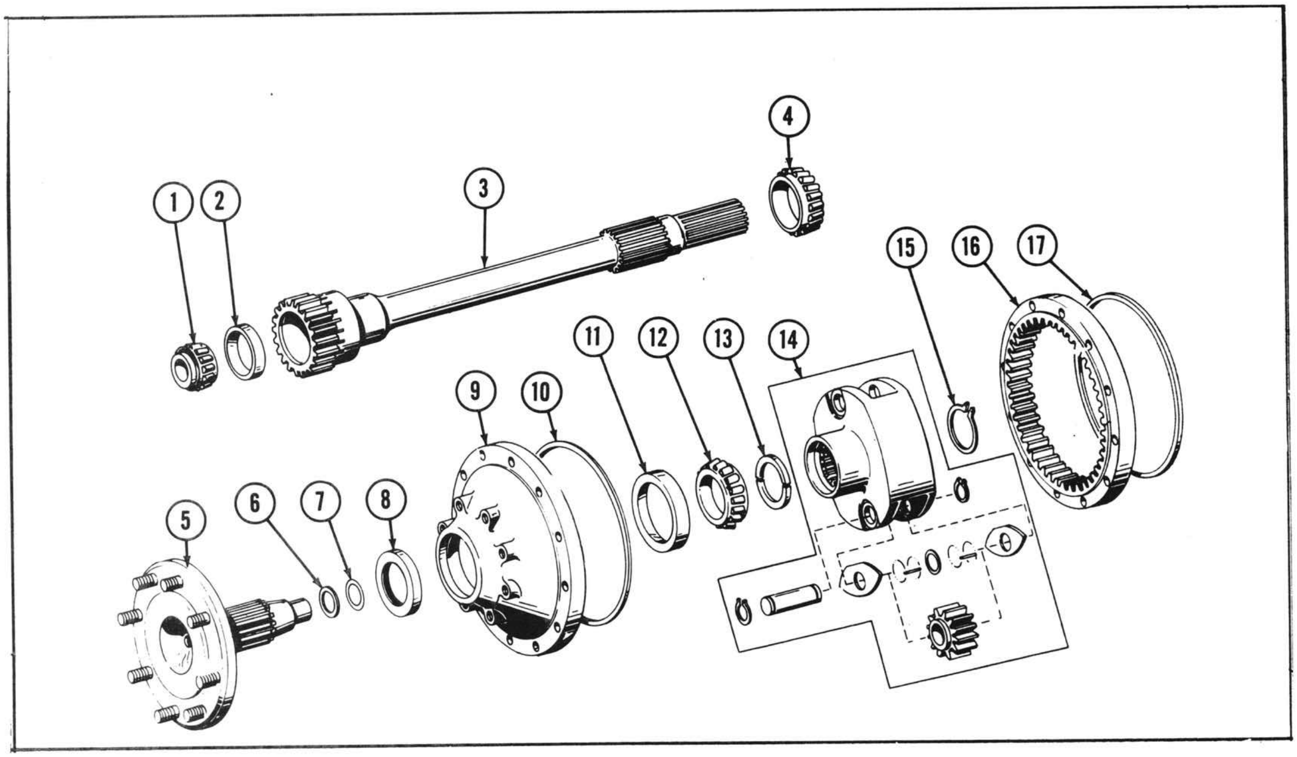

Fig. 10 - Rear Axle Assembly - Old Type
1. Tapered Bearing
2. Bearing Cup
3. Axle Shaft
4. Tapered Bearing
5. Wheel Axle
6. Shim (0.010")
7. Shim (0.002")
8. Oil Seal
9. Drive Cover
10. Gasket
11. Bearing Cup
12. Tapered Bearing
13. Bearing Support Ring
14. Planetary Carrier Assembly
15. Snap Ring
16. Planetary Ring Gear
17. Gasket

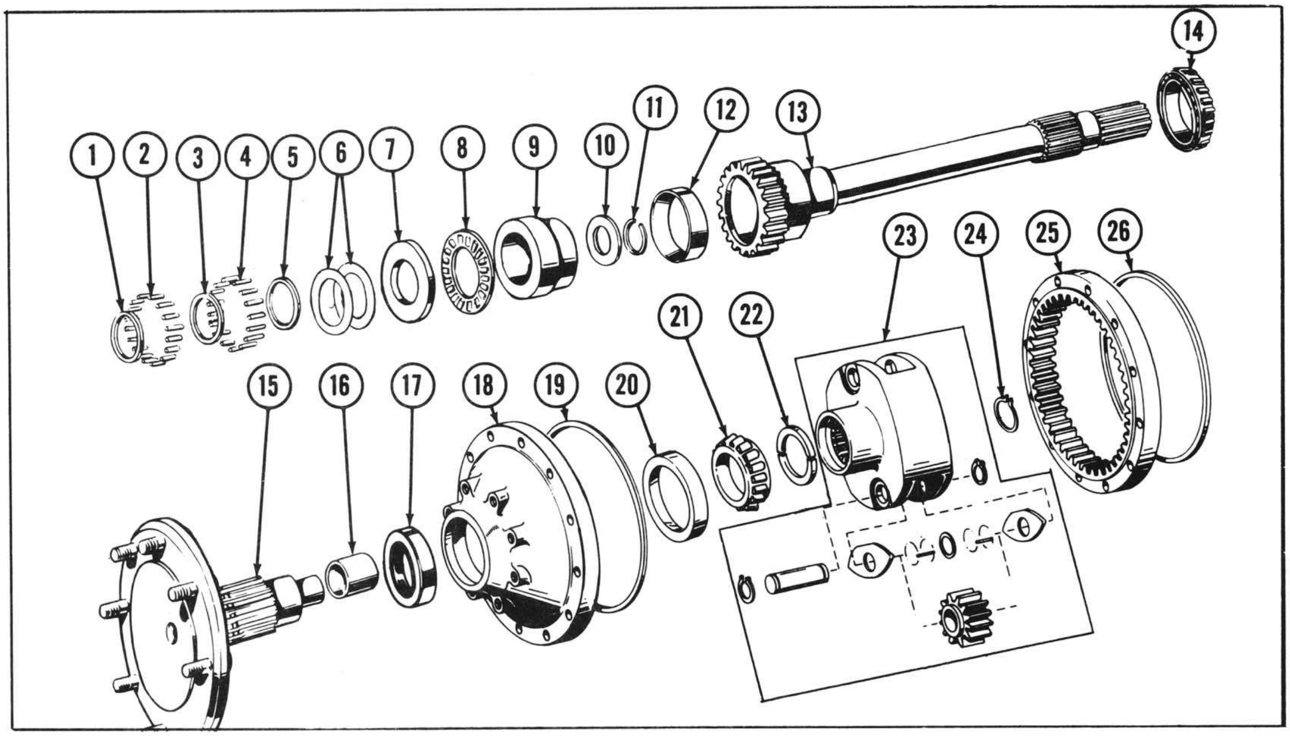

Fig. 11 - Rear Axle Assembly - New Type

1. Spacer
2. Path of 34 Rollers
3. Spacer
4. Path of 34 Rollers
5. Spacer
6. Shim
7. Thrust Bearing Race
8. Needle Thrust Bearing
9. Bearing Cup
10. Thrust Washer
11. Snap Ring
12. Bearing Cup
13. Rear Axle Shaft
14. Tapered Bearing
15. Wheel Axle
16. Wheel Axle Sleeve
17. Oil Seal
18. Drive Cover
19. Gasket
20. Bearing Cup
21. Tapered Bearing
22. Bearing Support Ring
23. Planetary Carrier Assembly
24. Snap Ring
25. Planetary Ring Gear
26. Gasket

Prepare the wheel axle assembly for installation:

Tractors up to Serial No. 662236 (Lo-Clearance) and 660007 (Hi-Clearance), see Fig. 10.

a. Construct a slave bearing by removing 0.002 inch of material from the inside diameter of a bearing cone. This eliminates having to press the production bearing on and off.

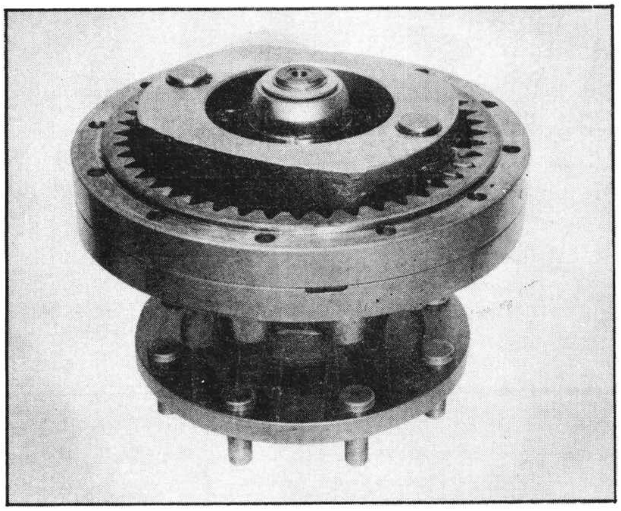

Fig. 12 - Wheel Axle Assembly

b. Install slave bearing to the wheel axle.

NOTE: Do not install any shims at this time.

Tractors after Serial No. 662236 (Lo-Clearance) and 660007 (Hi-Clearance), (see Fig. 11) install the following.

a. Sleeve (with chamfer down).

NOTE: Do not install any shims at this time.

b. The thrust race (with the chamfer down).

c. The roller bearing assembly (complete with rollers and spacers).

NOTE: Install with tapered end up.

d. Roller bearing washer and retaining ring.

3. Install the planetary internal drive gear and wheel axle assembly. Secure with three nuts and bolts spaced about 120° apart.

NOTE: Do not install gaskets at this time. Tighten bolts to 45 - 50 ft.-lbs. torque.

DETERMINE AXLE END-PLAY

1. Strike the center of the wheel axle with a bronze hammer to seat the bearing.

2. Install a dial indicator and determine axle end-play. See Page 2.

Remove the axle shaft and add sufficient shims to meet specifications as follows:

Tractors up to Serial No. 662236 (Lo-Clearance) and 660007 (Hi-Clearance), (see Fig. 10) remove the following:

a. Wheel axle assembly and planetary internal drive gear.

b. Slave bearing.

NOTE: Make sure that the slave bearing is removed and replaced with a production bearing.

c. Add shims of correct thickness and install bearing, planetary internal drive gear and wheel axle assembly.

NOTE: Use new gaskets during reassembly. Tighten bolts to a torque of 45 - 50 ft.-lbs.

Tractors after Serial No. 662236 (Lo-Clearance) and 660007 (Hi-Clearance), (see Fig. 11) remove the following:

a. Wheel axle assembly and planetary internal drive gear.

b. Snap ring and roller bearing assembly.

c. Thrust bearing and race.

d. Add shims of correct thickness and reassemble the wheel axle assembly.

e. Install the planetary internal drive gear and wheel axle assembly.

NOTE: Use new gaskets during reassembly. Tighten bolts to 45 - 50 ft.-lbs. torque.

COMPLETE THE ASSEMBLY

1. Position the tool shown on Page 2 and check the rolling torque of the rear axle.

2. Install the axle shaft and housing. Tighten the nuts to a torque of 50 ft.-lbs.

SERVICING THE COVER AND WHEEL AXLE ASSEMBLIES

REMOVING THE COVER AND WHEEL AXLE ASSEMBLIES

1. Support the tractor under the fender pad with a floor jack.

2. Remove the fender and wheel.

3. Drain the oil from the cover and wheel axle assemblies.

4. Remove the bolts attaching the axle housing to the wheel axle assembly and remove the wheel axle assembly as shown in Fig. 12.

DISASSEMBLING THE DRIVE COVER AND WHEEL AXLE ASSEMBLIES

Disassemble tractors prior to tractor Serial No. 662236 (Lo-Clearance) and 660007 (Hi-Clearance) as follows:

1. Remove:

a. The tapered bearing (No. 1, Fig. 10).

b. Shims from behind bearing if present.

c. Snap ring (No. 15, Fig. 10). Lift out the planetary carrier assembly (No. 14, Fig. 10).

d. Split bearing support ring (No. 13, Fig. 10).

NOTE: If necessary, press the wheel axle assembly (No. 5, Fig. 10) farther into the drive cover assembly (No. 9, Fig. 10).

2. Mount the drive cover and wheel axle assemblies in an arbor press as shown in Fig. 13.

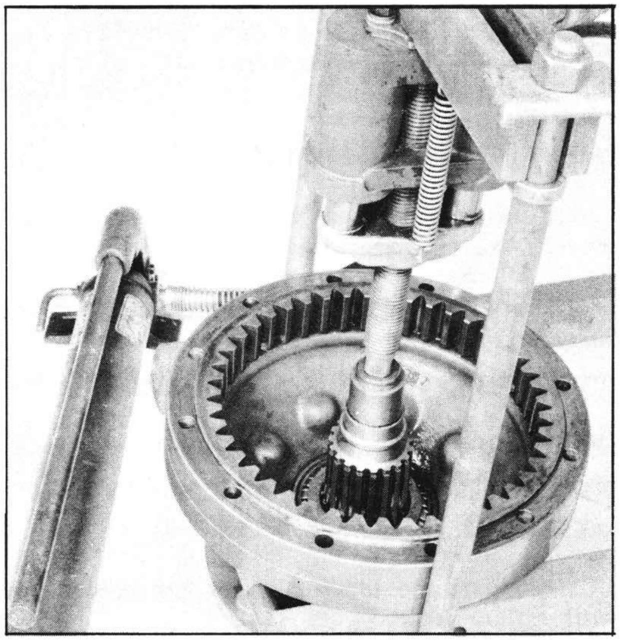

Fig. 13 - Removing the Taperea Bearing

3. Press the wheel axle out of the drive cover assembly.

NOTE: This removes the tapered bearing (No. 12, Fig. 10).

4. Complete the disassembly of the drive cover by removing:

a. The oil seal (No. 8, Fig. 10) as shown in Fig. 14.

b. The bearing cup (No. 11, Fig. 10) as shown in Fig. 15.

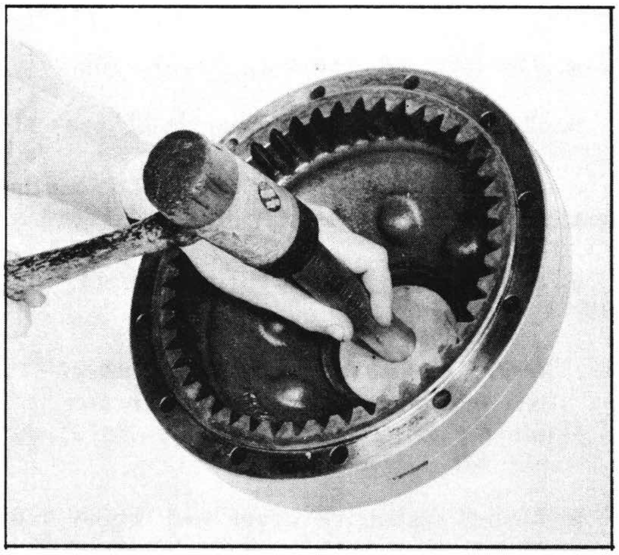

Fig. 14 - Removing the Oil Seal

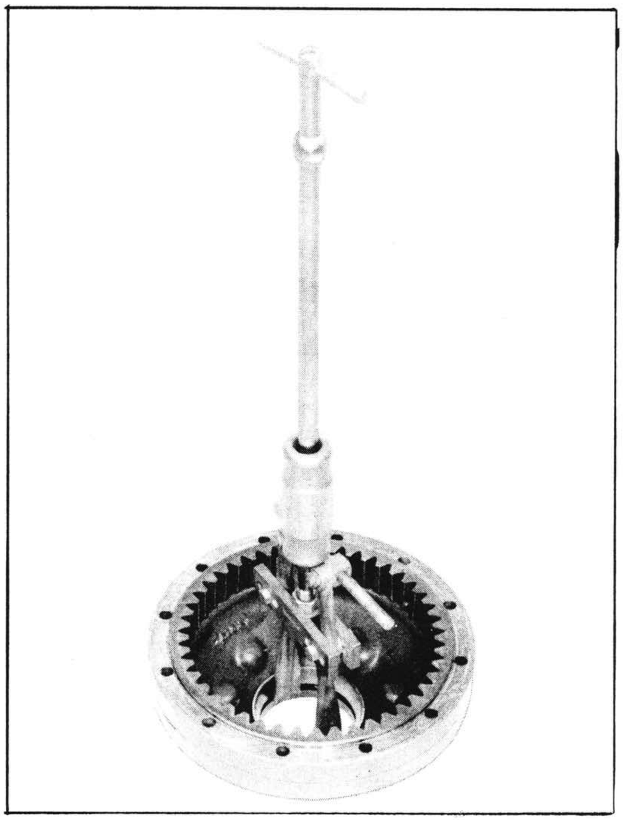

Fig. 15 - Removing the Bearing Cup

DISASSEMBLING THE DRIVE COVER AND WHEEL AXLE ASSEMBLIES

Disassemble tractors after tractor Serial No. 662236 (Lo-Clearance) and 660007 (Hi-Clearance) as follows:

1. Remove:

a. Snap ring (No. 11, Fig. 11).

b. Thrust washer (No. 10, Fig. 11).

c. Thrust washer (No. 7), thrust bearing (No. 8) and bearing cone (No. 9, Fig. 11) as a unit.

NOTE: Hold these assemblies in a vertical position to keep the 68 loose needle bearings and spacers in position.

d. The shims (No. 6, Fig. 11) from behind bearing cone, if present.

e. The snap ring (No. 24, Fig. 11). Lift out the planetary carrier assembly.

f. Split bearing support ring (No. 22, Fig. 11).

NOTE: If necessary, press the wheel axle assembly farther into the drive cover assembly to release the support ring.

2. Mount the drive cover and wheel axle assemblies in an arbor press as shown in Fig. 13.

3. Press the wheel axle out of the drive cover.

NOTE: This removes the tapered bearing (No. 21, Fig. 11).

4. Complete the disassembly of the drive cover by removing:

a. The oil seal (No. 17, Fig. 11) as shown in Fig. 14.

b. The bearing cup (No. 20, Fig. 11) as shown in Fig. 15.

INSPECTING AND SERVICING THE DRIVE COVER AND WHEEL AXLE ASSEMBLIES

1. Inspect the following:

a. Split bearing retainer (for wear).

b. Wheel axle (for damage).

c. Bearing cups (for wear and pitting).

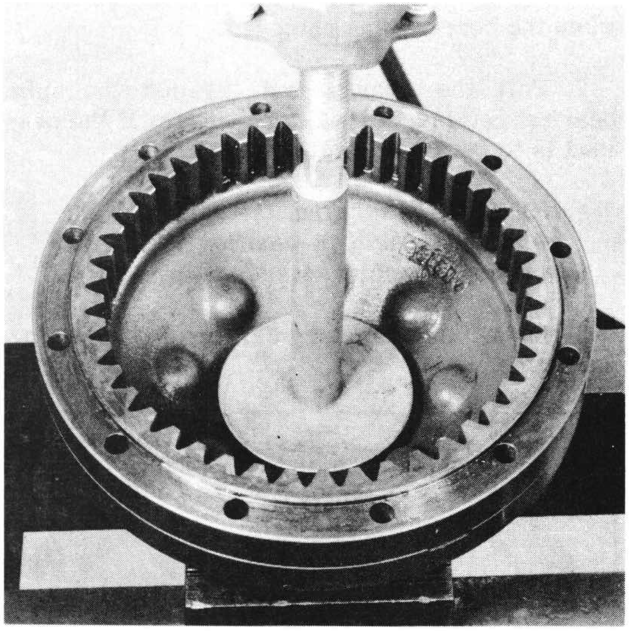

Fig. 16 - Installing the Bearing Cup

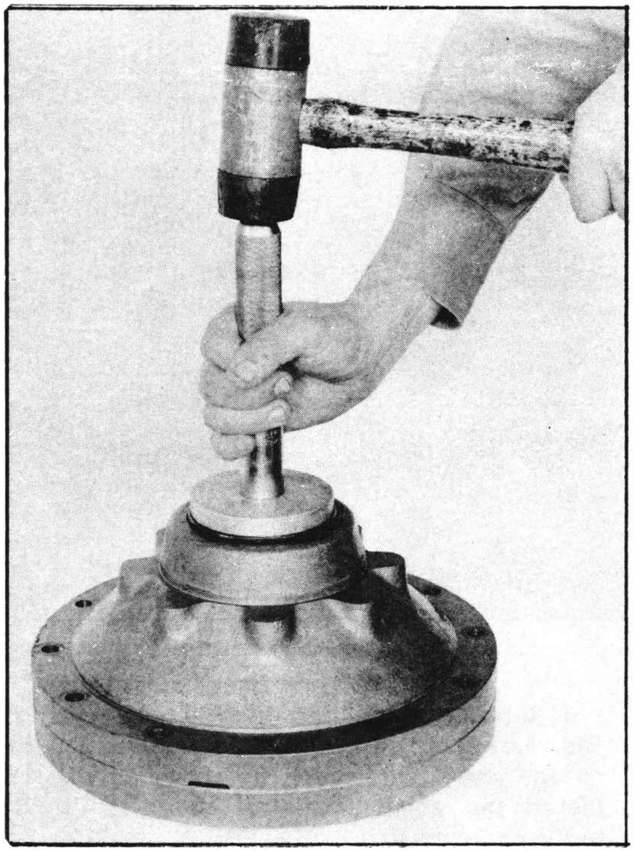

Fig. 17 - Installing the Oil Seal

d. Bearings (for wear and freedom of movement).

e. Drive cover (for damage).

NOTE: Whenever replacing oil seals, always use a light coating of gasket sealing compound in the oil seal bore.

2. Replace the above parts not meeting minimum specifications.

ASSEMBLING THE DRIVE COVER AND WHEEL AXLE ASSEMBLIES

1. Mount the drive cover in an arbor press. Using a step plate and driver, press in the bearing cup until it bottoms in the cover. See Fig. 16.

2. Using a step plate, install a new or serviceable oil seal in the cover. See Fig. 17.

NOTE: Lubricate the oil seal with brake fluid before installing the axle shaft.

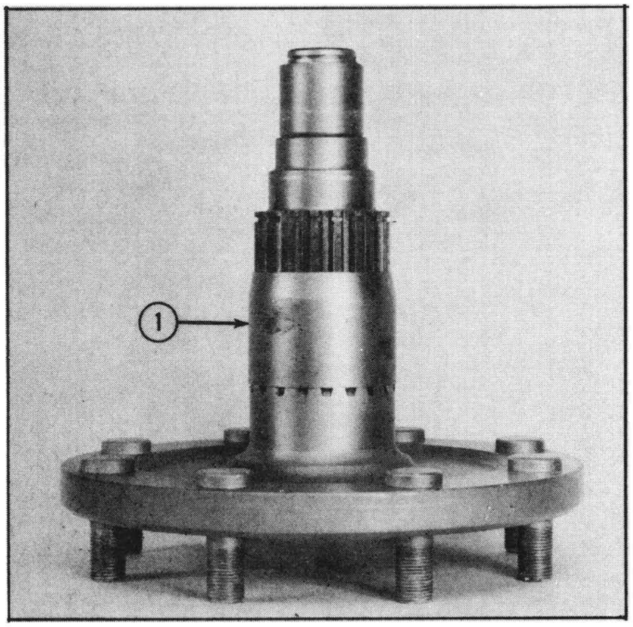

Fig. 18 - Installing Tool MF 11
1. Tool MF 11

3. Install the seal protector, Tool No. MF-11 (No. 1, Fig. 18), from OTC set number MF-400 on the wheel axle shaft, as shown in Fig. 18. Install the wheel axle shaft shown in Fig. 19 in the drive cover.

4. Mount the drive cover and wheel axle in a press and press the wheel axle bearing on far enough to install the split bearing retainer. See Fig. 20.

5. Install the split bearing retainer.

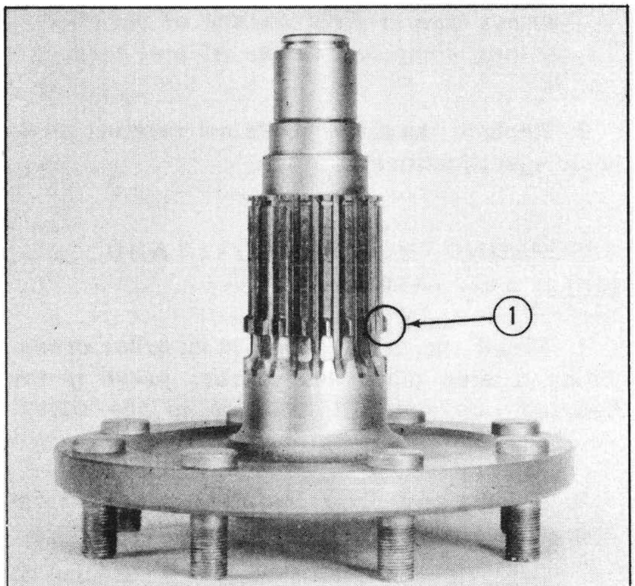

Fig. 19 - Wheel Axle
1. Raised Spline

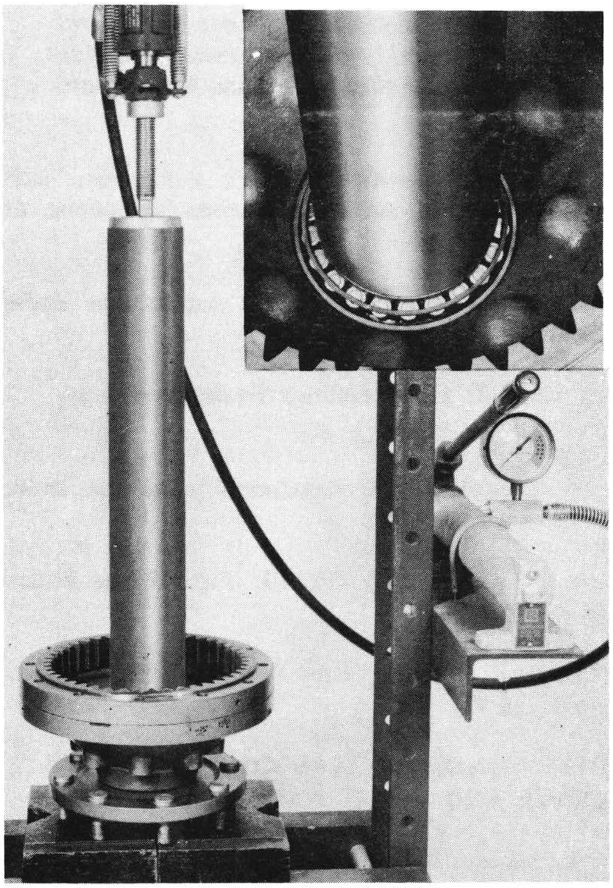

Fig. 20 - Installing the Tapered Bearing

NOTE: Install retainer so that the beveled edge, shown in Fig. 21, is towards the planetary.

6. Mount the assembly in the press as it was when the bearing was removed.

7. Pull the bearing out, against the split bearing retainer. This is necessary if the preload is to be set accurately.

NOTE: Make sure that the split bearing retainer is held in position while the bearing is being backed-up against it.

8. Install the planetary carrier and retaining snap ring.

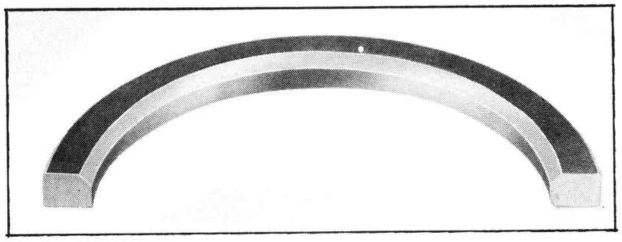

Fig. 21 - Bearing Support Ring

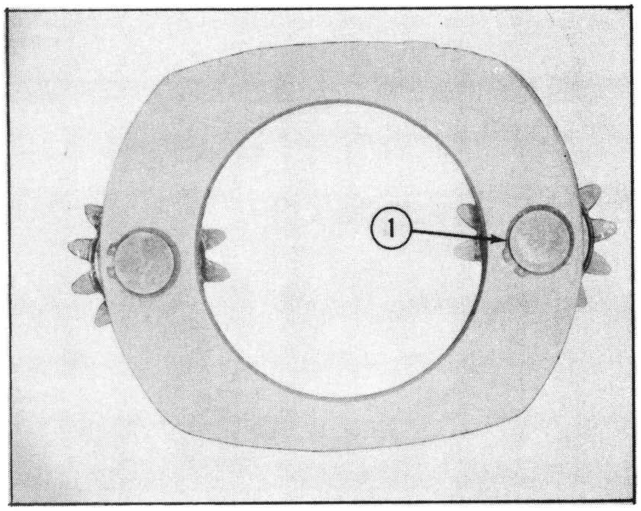

Fig. 22 - Planetary Carrier Assembly
1. Snap Ring

SERVICING THE PLANETARY CARRIER

DISASSEMBLING THE PLANETARY CARRIER

1. Remove the snap ring (No. 1, Fig. 22).

2. Press out the planetary pinion shaft as shown in Fig. 23.

> *NOTE: There are two paths of rollers with 29 loose rollers in each path and 1 spacer in each of the planetary pinion gears.*

3. Remove the pinion gear (No. 6, Fig. 24) and the two thrust washers (Nos. 3 and 8, Fig. 24) from the carrier.

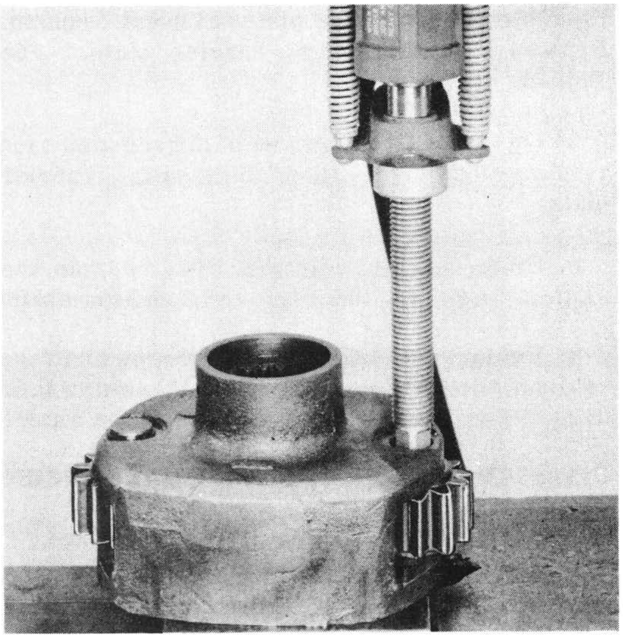

Fig. 23 - Removing Pinion Gear

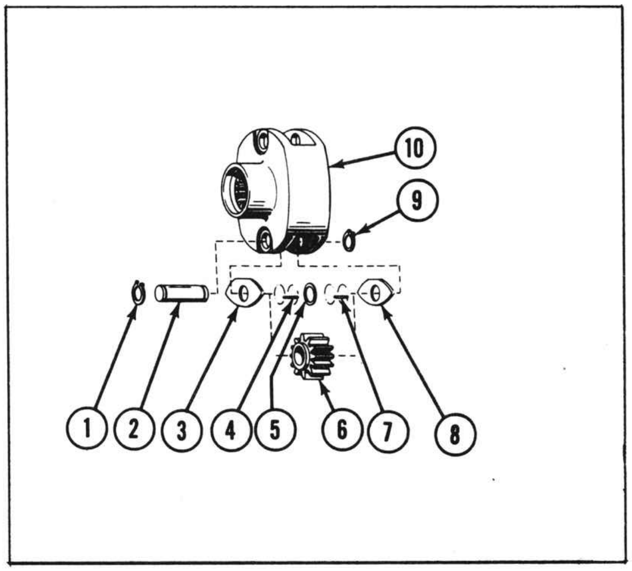

Fig. 24 - Planetary Carrier Assembly

1. Snap Ring
2. Pinion Gear Shaft
3. Thrust Washer
4. Path of 29 Rollers
5. Spacer
6. Pinion Gear
7. Path of 29 Rollers
8. Thrust Washer
9. Snap Ring
10. Planetary Carrier

INSPECTING AND SERVICING THE PLANETARY CARRIER ASSEMBLY

1. Inspect the following:

a. Planetary pinion gears (for damage).

b. Thrust washers (for excessive wear.)

c. The planetary carrier and its internal splines (for damage).

2. Replace the above parts not meeting minimum specifications.

ASSEMBLING THE PLANETARY CARRIER ASSEMBLY

1. Install the following:

a. Snap ring on one end of the planetary pinion gear shaft (No. 2, Fig. 24).

b. A path of rollers, a spacer, and a second path of rollers into the planetary pinion gear.

> *NOTE: Use heavy grease to help hold the rollers in place.*

c. A thrust washer on each side of the planetary pinion gear. Insert the gear into the carrier.

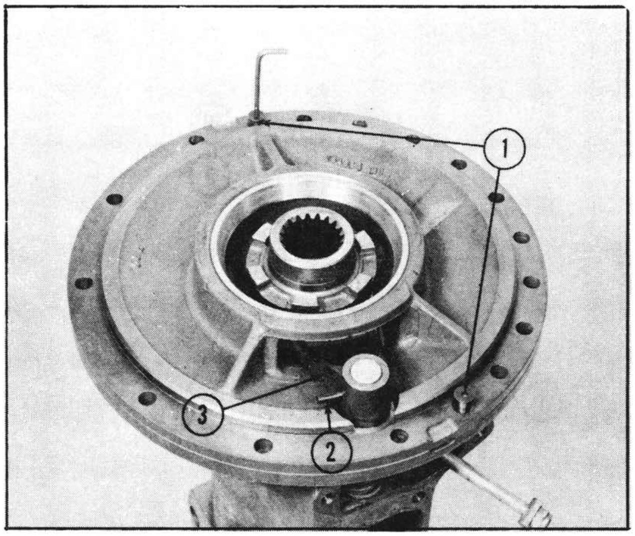

Fig. 25 - End View - Axle Housing Assembly
1. Set Screws 2. Roll Pin 3. Shift Fork

2. Using an arbor press, install the planetary pinion gear shaft until the snap ring is against the planetary carrier.

3. Position the second snap ring on the planetary pinion gear shaft.

SERVICING THE DIFFERENTIAL CARRIER PLATES

Both differential carrier plates on the tractors not having the differential lock are similar and vary only in the tapered bearing.

On tractors with the differential lock, the right differential carrier plate is considerably different from the left.

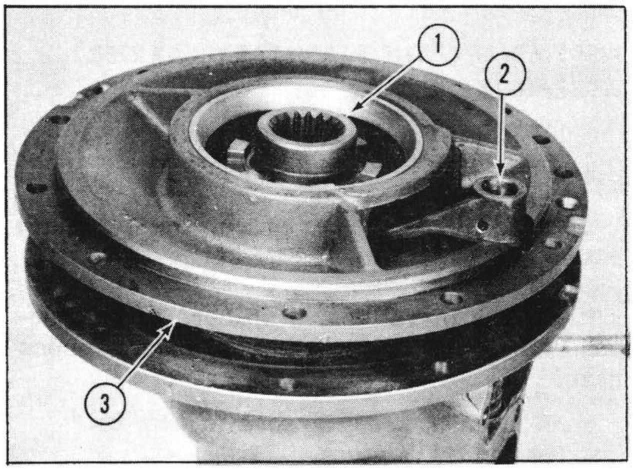

Fig. 26 - End View - Axle Housing Assembly
1. Differential Lock Coupler
2. Lock Shifter Fork
3. Differential Carrier Plate

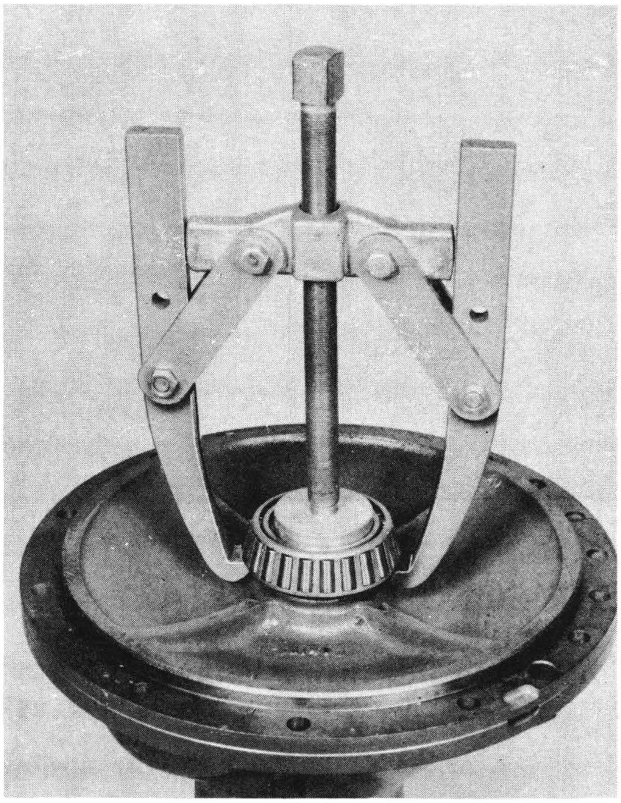

Fig. 27 - Removing Tapered Bearing

REMOVING THE DIFFERENTIAL CARRIER PLATES

1. Remove the following:

a. Axle shaft and housing (as a unit).

b. Allen head bolts (No. 1, Fig. 25) securing the differential carrier plate to the axle housing. Remove the differential carrier plate. See Fig. 25.

2. On those tractors with differential lock remove the right hand differential carrier plate:

a. Drift out the roll pin (No. 2) from the shifter fork (No. 3, Fig. 25) and lock shaft.

b. Remove the Allen head setscrews and then take off the carrier plate (No. 3), shifter fork (No. 2) and coupler (No. 1, Fig. 26) as a unit.

DISASSEMBLING THE DIFFERENTIAL CARRIER PLATES

1. Remove the following:

a. The tapered bearing as shown in Fig. 27.

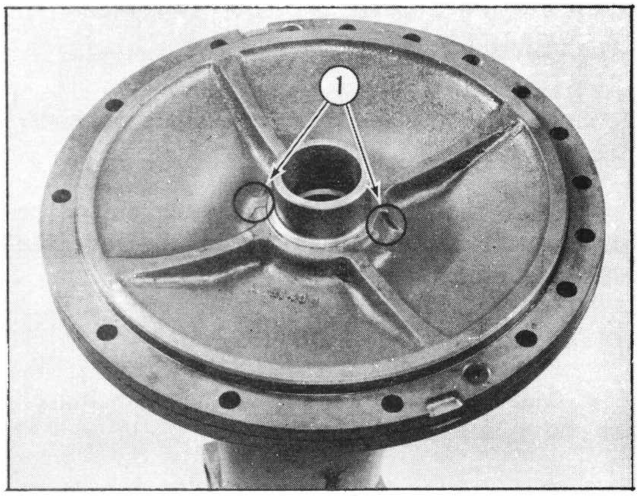

Fig. 28 - Differential Carrier Plate

1. Recessed Area

NOTE: Make sure that the puller contacts the inner race only. Use recessed areas (No. 1, Fig. 28) in the casting when installing puller.

b. Oil seal as shown in Fig. 29.

c. Bearing cup as shown in Fig. 30 (on ractors equipped with differential lock).

d. Differential lock shaft oil seal (on tractors with the differential lock).

INSPECTING AND SERVICING THE DIFFERENTIAL CARRIER PLATE ASSEMBLIES

1. Inspect the following:

a. Tapered bearings (for wear and freedom of movement).

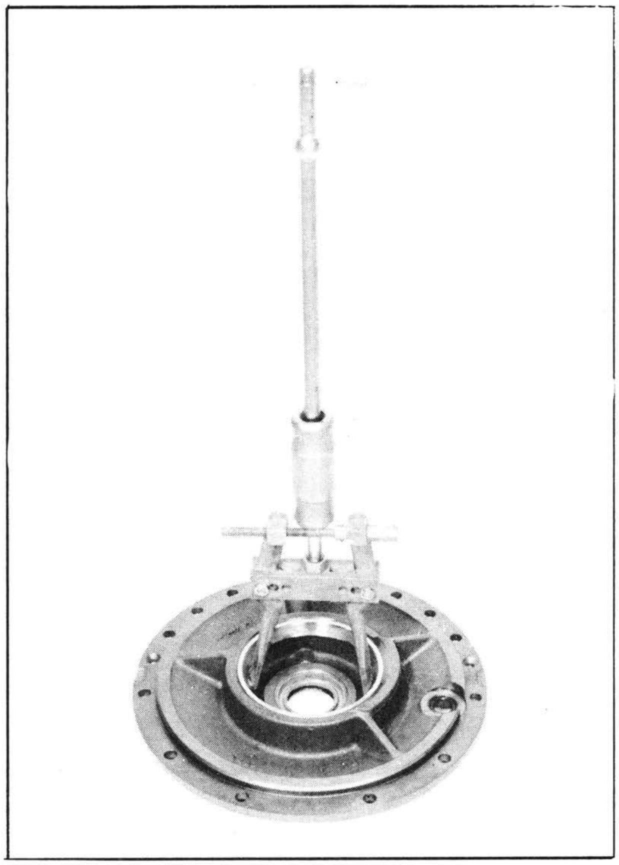

Fig. 30 - Removing the Bearing Cup

b. The bearing cups (for damage).

c. All oil seals (for damage).

d. Carrier plates (for damage).

2. Replace all of the above parts not meeting minimum specifications.

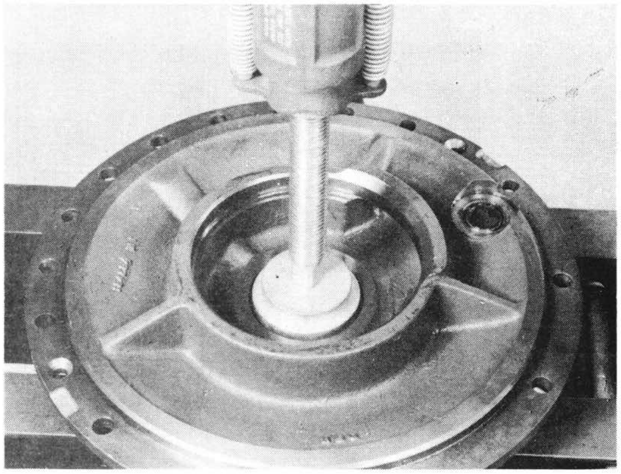

Fig. 29 Removing the Oil Seal

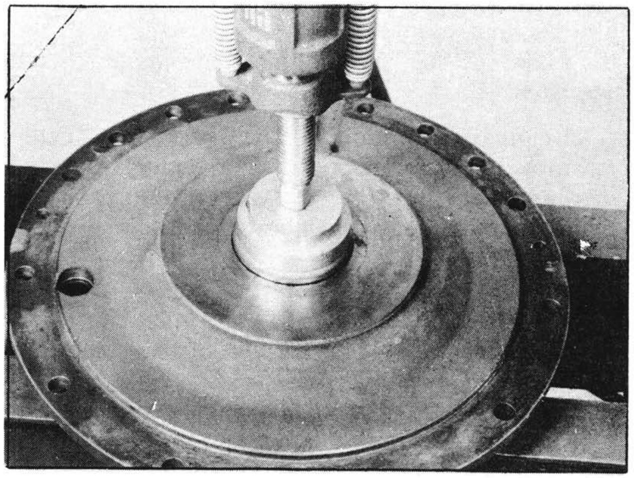

Fig. 31 - Installing the Oil Seal

ASSEMBLING THE DIFFERENTIAL CARRIER PLATE

1. Install:

a. The oil seals as shown in Fig. 31.

NOTE: Apply a coating of gasket sealing compound. Wipe away excess after pressing in the oil seal.

b. The bearing cup until it bottoms in the recess in the carrier plate.

2. Press the tapered bearing onto the carrier plate.

NOTE: The larger tapered bearing is positioned on the ring gear side of the differential. Make sure that the pressing sleeve only makes contact with the inner race of the bearing.

INSTALLING THE DIFFERENTIAL CARRIER PLATES

To install the differential carrier plates, reverse the removal procedure. Always use new gaskets. Torque Allen head bolts at 10 to 12 ft.-lbs.

DIFFERENTIAL AND PINION ASSEMBLY

The driving pinion is supported in the differential center housing by a straight roller pilot bearing and a preloaded sleeve assembly holding two tapered roller bearings.

The ring gear is bolted to the split differential case, which is supported by tapered roller bearings running in cups fitted to the differential carrier plates. The differential pinions are mounted on a spider and the thrust is taken up by pinion and side gear thrust washers.

The driving pinion is coupled to the transmission rear drive shaft by a double grooved tubular shear member, fitted to minimize damage under exceptional shock loading.

NOTE: At transmission Serial No. CL26861L2, a change in the pinion shaft bearing cups, bearing cup housing and tapered bearing was made. Be sure to refer to the transmission serial number, stamped next to the neutral safety switch, whenever ordering these parts.

SERVICING THE DIFFERENTIAL ASSEMBLY

REMOVING THE DIFFERENTIAL

1. Remove the left rear axle shaft and housing as a unit. See Page 2.

2. Slide the differential assembly out of the differential center housing from the left side of the tractor.

DISASSEMBLING THE DIFFERENTIAL

1. Mark the relationship of the case halves as shown in Fig. 32.

2. Remove the left hand bearing cup large (No. 3, Fig. 33) as shown in Fig. 35.

3. On tractors without the differential lock, remove the right hand bearing cup small (No. 13, Fig. 33).

4. On tractors with the differential lock, remove the tapered bearing as shown in Fig. 36.

5. Remove the locking wire and bolts holding the differential case halves together.

6. The ring gear may be removed from the differential case y removing the securing nuts.

INSPECTING THE DIFFERENTIAL

1. Inspect the following:

a. Gears and bearings of the assembly (for damage).

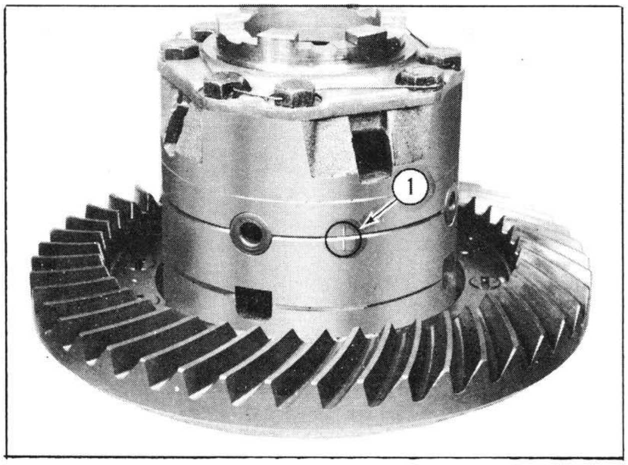

Fig. 32 - The Differential Assembly
1. Scribe Mark

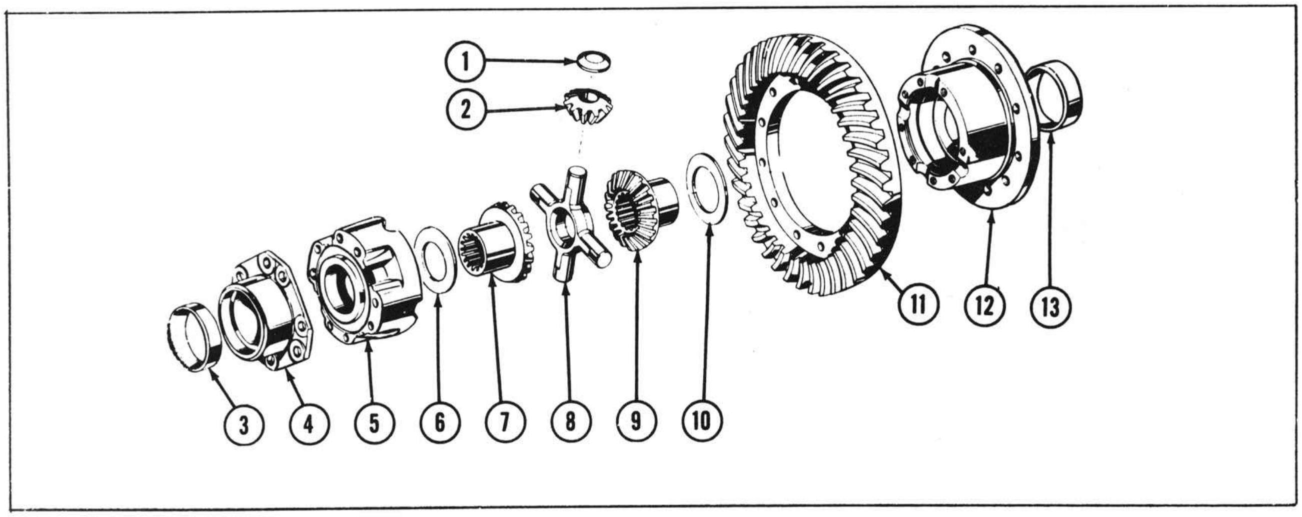

Fig. 33 - Differential Assembly - Without Differential Lock

1. Thrust Washer
2. Pinion Gear
3. Bearing
4. Differential Adaptor
5. Differential Case Half
6. Thrust Washer
7. Side Gear
8. Spider
9. Side Gear
10. Thrust Washer
11. Ring Gear
12. Differential Case Half
13. Bearing Cup

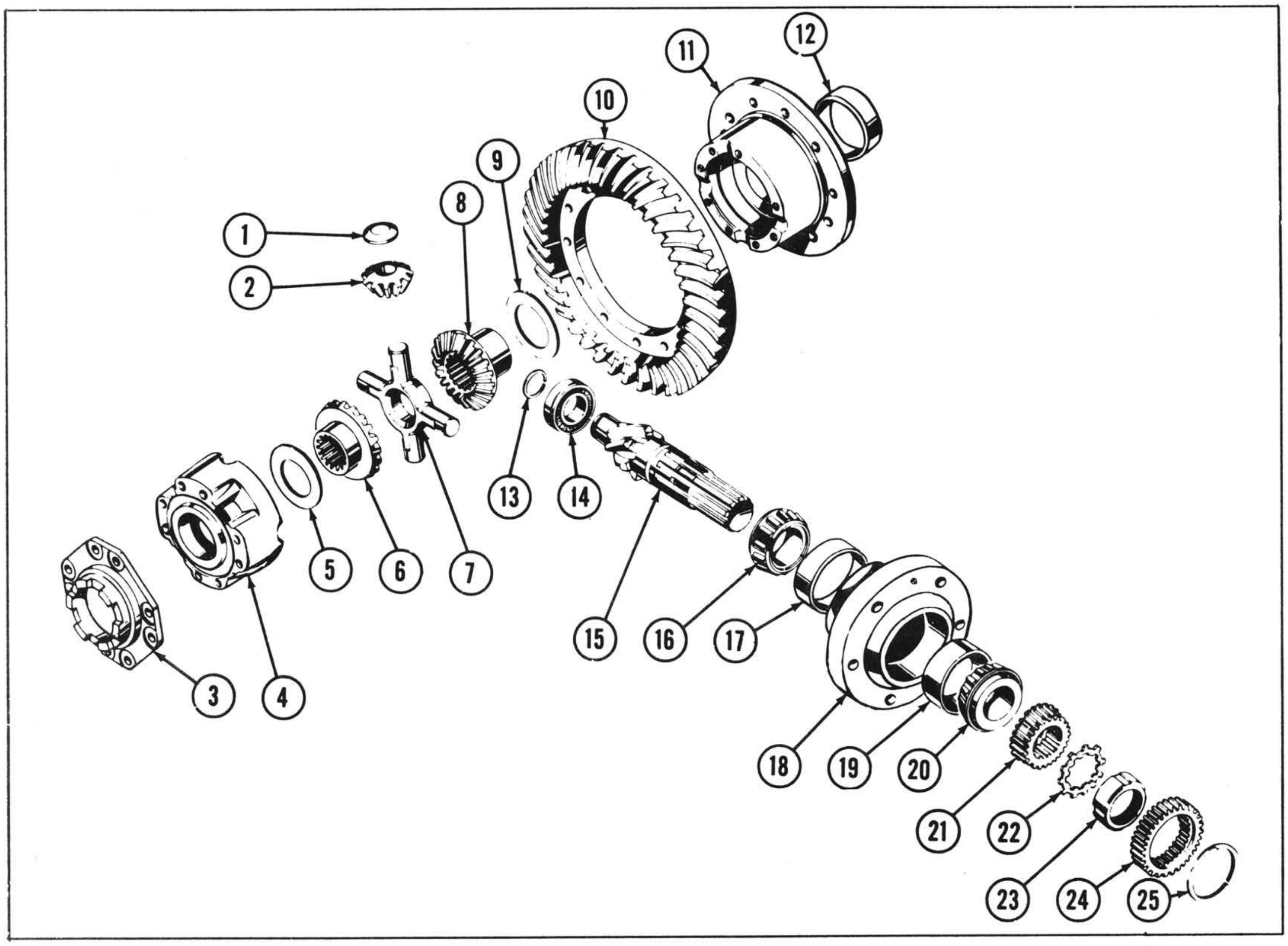

Fig. 34 - Differential Assembly - With Differential Lock

1. Thrust Washer
2. Pinion Gear
3. Differential Lock Adaptor
4. Differential Case Half
5. Thrust Washer
6. Side Gear
7. Spider
8. Side Gear
9. Thrust Washer
10. Ring Gear
11. Differential Case Half
12. Bearing Cup
13. Snap Ring
14. Pinion Pilot Bearing
15. Drive Pinion Shaft
16. Tapered Bearing (Inner)
17. Bearing Cup
18. Bearing Cup Housing
19. Bearing Cup
20. Tapered Bearing
21. PTO Drive Gear Hub
22. Tab Lock Washer
23. Lock Nut
24. PTO Drive Gear
25. Spiral Snap Ring

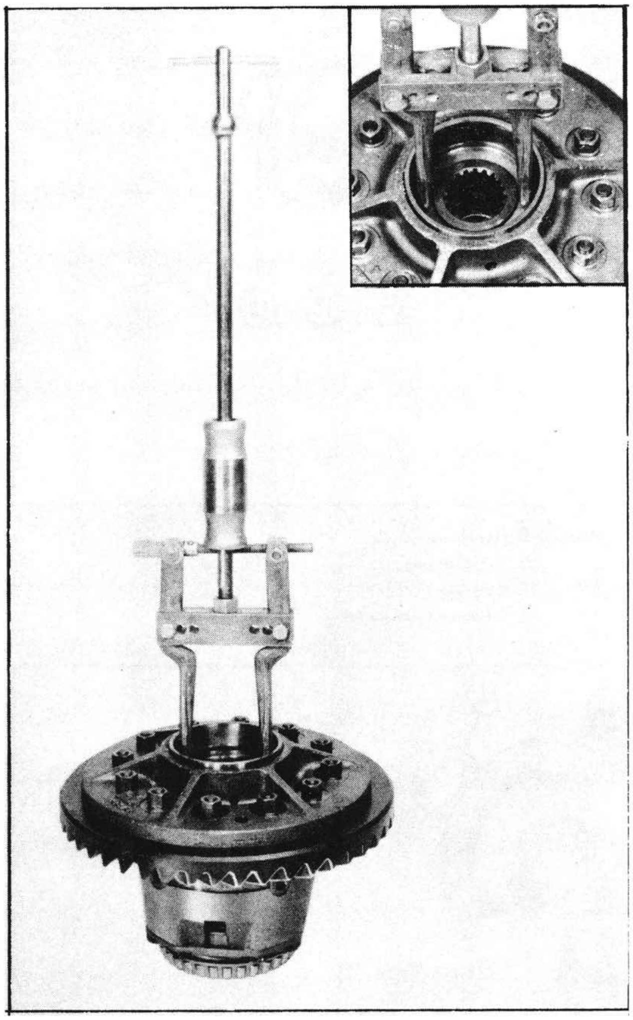

Fig. 35 - Removing Bearing Cup

b. Thrust washers (for wear).

c. The bearing cups (for damage).

2. Replace any of these parts below minimum specifications.

ASSEMBLING THE DIFFERENTIAL

1. Attach the ring gear to the differential case with Loctite sealant cement, grade AV, treated bolts (825776M1) nuts (891947M1), as follows:

a. Nuts and bolts are to be degreased with trichloroethylene or a similar solvent.

b. Apply two drops of Loctite sealant, Grade AV, evenly to the first three threads of the bolts.

c. Assemble differential case and ring gear using bolts treated with Loctite.

d. Tighten the nuts to 110-120 ft.-lbs. torque.

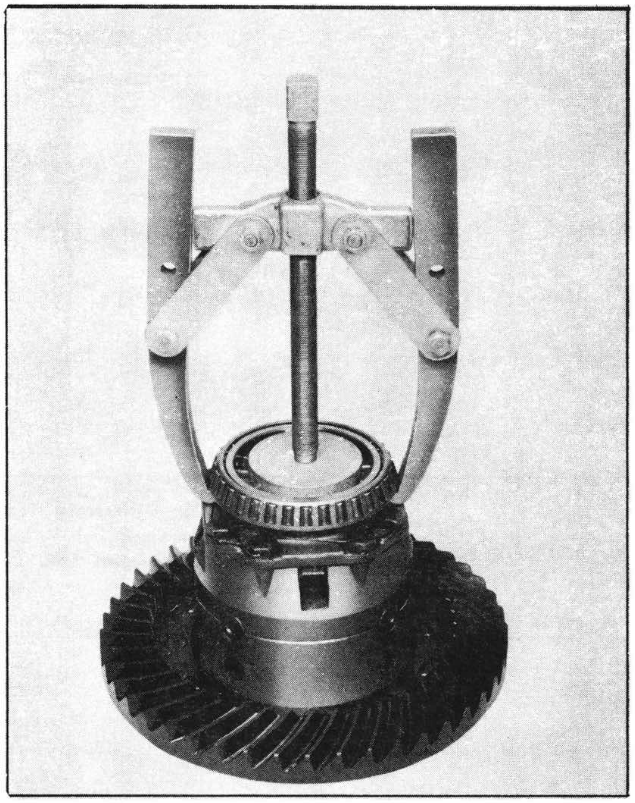

Fig. 36 - Removing Tapered Bearing

2. Place the left hand differential case on the bench with the teeth of the ring gear up.

3. Install the following:

a. The thrust washer (No. 9) and side gear (No. 8, Fig. 45) in the case as shown in Fig. 37.

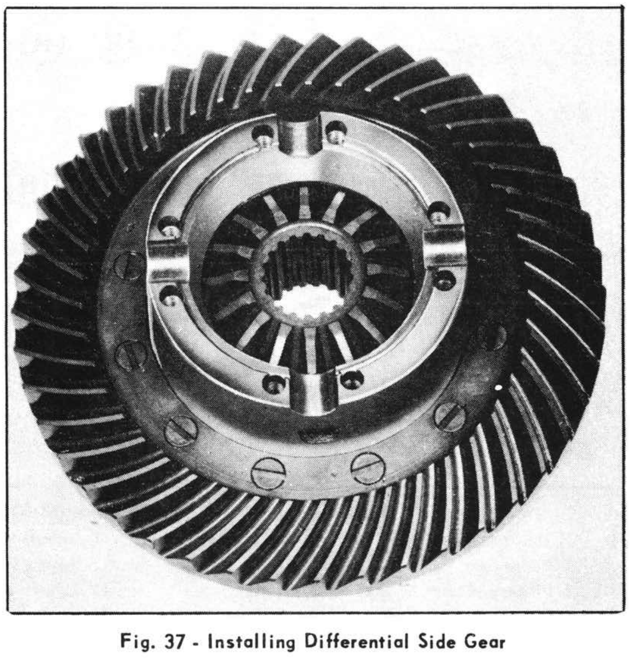

Fig. 37 - Installing Differential Side Gear

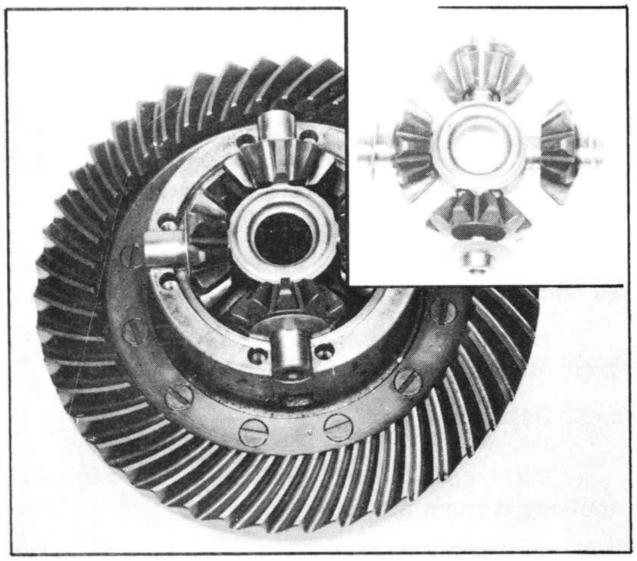

Fig. 38 - Installing Spider and Pinions

b. Spider (No. 7), pinion gears (No. 2) and thrust washers (No. 1, Fig. 34) on the side gear as shown in Fig. 38.

c. Remaining side gear (No. 6) and thrust washer (No. 5, Fig. 34) as shown in Fig. 39.

> *NOTE: The entire unit will look like Fig. 40 when inserted in the differential case.*

d. Right hand differential case and secure with bolts. Tighten the bolts to 47 - 53 ft.-lbs. torque and lock with wire.

> *NOTE: Make sure that the identification marks (No. 1, Fig. 32) are aligned.*

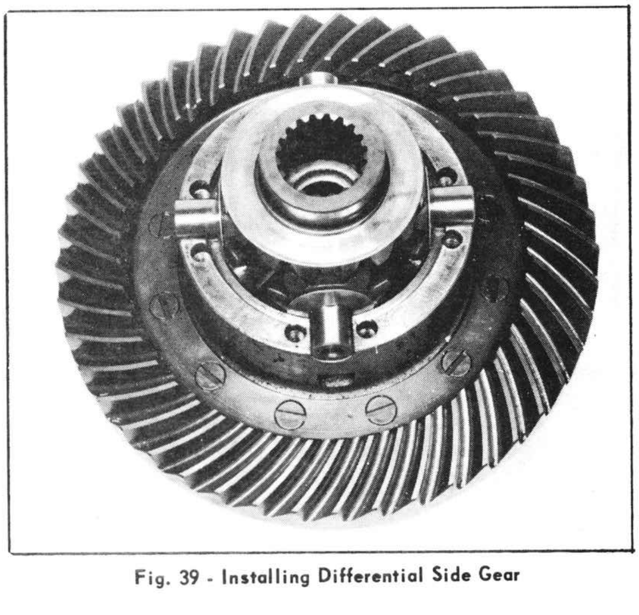

Fig. 39 - Installing Differential Side Gear

4. Press the bearing onto the differential case and the bearing cup into the recess in the differential case.

5. Using a dial indicator, check the backlash between the side gears and the pinion.

> *NOTE: Recommended backlash is 0.003 to 0.011 inch and is nonadjustable. Excessive backlash indicates that the differential pinion and side gear thrust washers are worn and must be replaced.*

DIFFERENTIAL LOCK

On tractors equipped with the differential lock, the right hand differential case adaptor is replaced by a differential coupling cap with a dog coupling. When the differential lock pedal is depressed, an actuating cam meshes the two halves of the coupling, locking the differential. The differential lock pedal is spring-loaded to insure disengagement when the operator's foot is removed from the pedal. It is necessary, however, to break the tractor's forward line of travel or touch the right individual brake to disengage the dog coupling.

> *NOTE: At transmission serial number SNY51686, a change was made in the differential lock pedal housing. Be sure to refer to the serial number when ordering parts.*

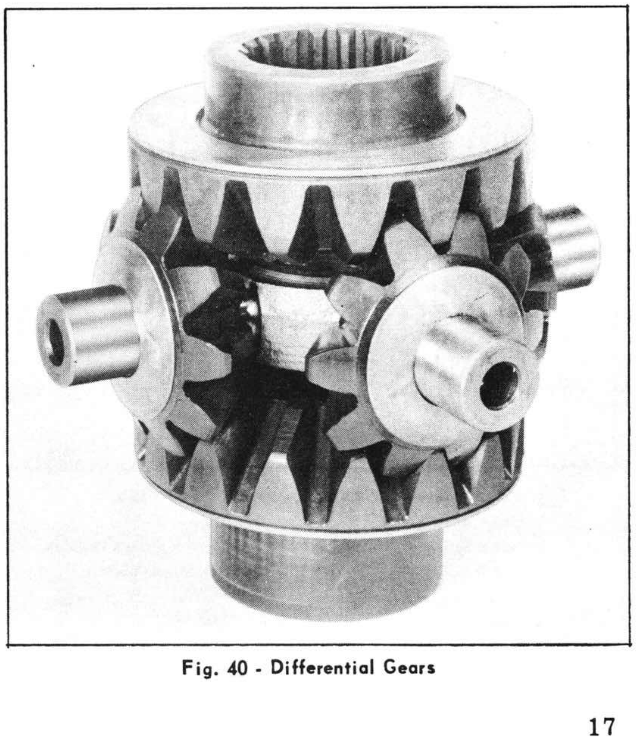

Fig. 40 - Differential Gears

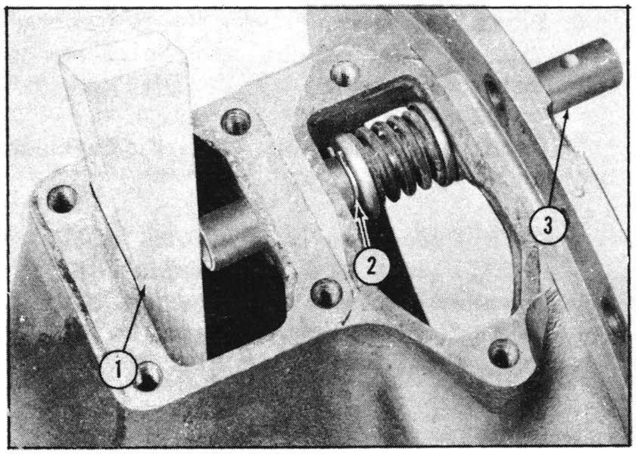

Fig. 41 - Removing Differential Lock Shaft
1. Wooden Wedge
2. Snap Ring
3. Differential Lock Shaft

SERVICING THE DIFFERENTIAL LOCK

REMOVING THE DIFFERENTIAL LOCK

1. Remove the following:

a. Right cover and wheel axle assembly as outlined on Page 7.

b. Right axle shaft and housing as a unit. See Page 2.

> *NOTE: Remove the axle shaft and set the axle housing on the floor with the differential lock mechanism end up.*

c. Bolts securing the differential lock pedal and cam housing to the axle housing.

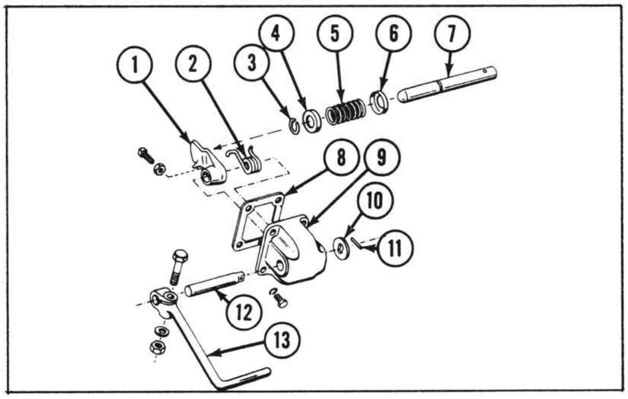

Fig. 42 - Differential Lock Assembly - Old Type
1. Lock Cam
2. Return Spring
3. Snap Ring
4. Spring Cap
5. Spring
6. Spring Cap
7. Differential Lock Shaft
8. Gasket
9. Differential Lock Housing
10. Shaft Thrust Washer
11. Roll Pin
12. Pedal Shaft
13. Pedal

> *NOTE: When assembling this unit, tighten these bolts to 35 ft.-lbs. torque.*

d. Differential carrier plate, shifter fork and coupler as a unit as outlined on Page 12.

e. Brake assembly and friction discs. See Group IV, Section B, Part 2.

2. Install a wooden wedge (No. 1, Fig. 41) to compress the spring.

3. Release the snap ring (No. 2, Fig. 41) from its groove.

4. Remove:

a. Differential lock shaft (No. 3, Fig. 41) (pulling it from the top).

b. Compressed spring and snap ring from the housing. See Figs. 42 and 43.

> *NOTE: The spring is still compressed. Place some type of covering over the spring and housing before removing the spring from the housing.*

DISASSEMBLING THE DIFFERENTIAL LOCK PEDAL HOUSING

1. Loosen the pinch bolt and remove the pedal.

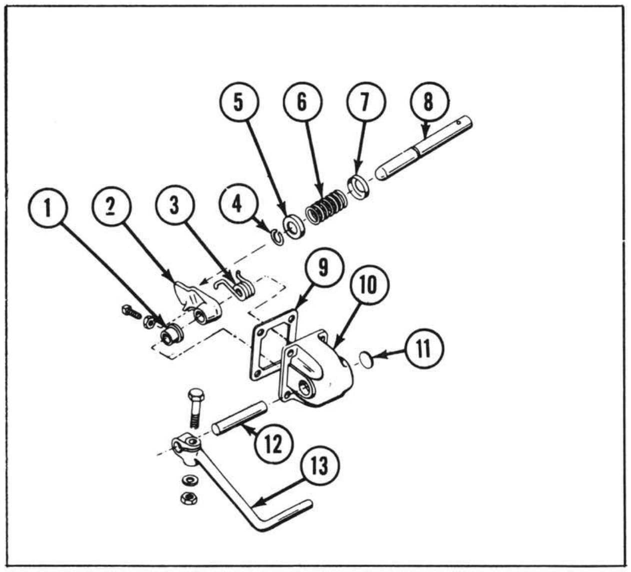

Fig. 43 - Differential Lock Assembly - New Type
1. Bearing Sleeve
2. Lock Cam
3. Return Spring
4. Snap Ring
5. Spring Cap
6. Spring
7. Spring Cap
8. Differential Lock Shaft
9. Gasket
10. Differential Lock Housing
11. Expansion Plug
12. Pedal Shaft
13. Pedal

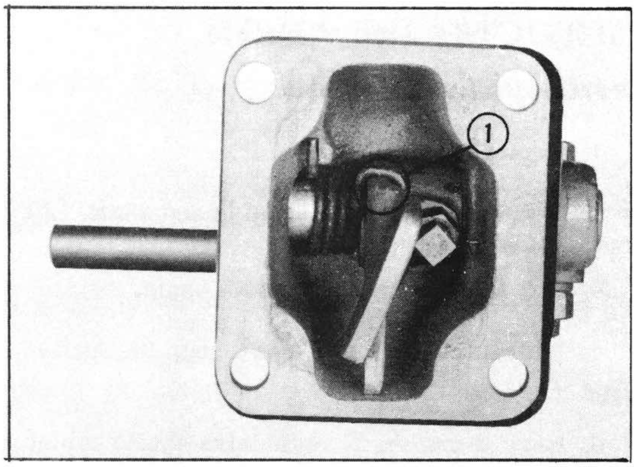

Fig. 44 - Differential Lock Pedal Housing
1. Hooked Portion of Spring

2. Use a heavy screwdrive to pry the hook portion of the spring (No. 1, Fig. 44) from the shoulder of the differential cam.

3. Loosen the lock nut and remove the lock screw.

4. Remove the shaft from the housing; allow the spring and cam to fall free.

> *NOTE: On tractors prior to transmission Serial Number SNY51686, drift out the roll pin (No. 11) and remove the thrust washer (No. 10, Fig. 42) when removing the shaft.*

5. Install the shaft in its bore. Use a bronze hammer to drive out the expansion plug (No. 11, Fig. 43) from the housing.

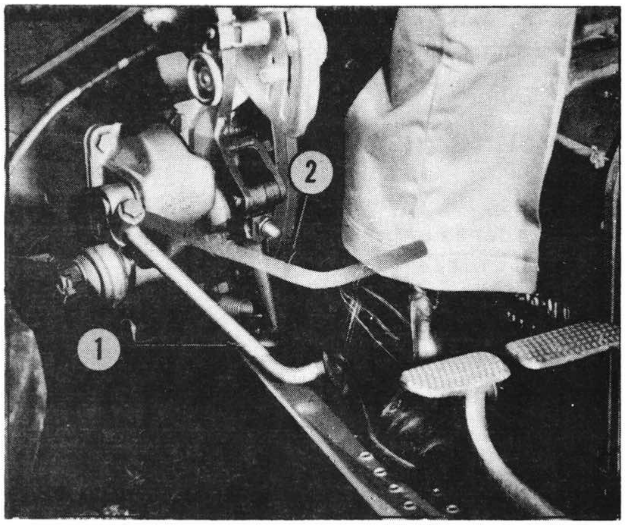

Fig. 45 - Differential Lock Operation
1. Engaged Position
2. Disengage Position

6. Use a step plate and driver to remove the bronze bearing sleeve from the housing.

INSPECTING AND SERVICING THE DIFFERENTIAL LOCK AND PEDAL HOUSING

Carefully inspect the parts of the differential lock and the pedal housing for excessive wear. Replace damaged parts.

> *NOTE: Use a light coating of gasket sealing compound between the oil seal and its bore.*

ADJUSTING THE DIFFERENTIAL LOCK

The differential lock should be fully engaged as the pedal contacts the step plate on its downward stroke, see Fig. 45. To adjust, loosen the clamp bolt slightly so that the pedal can be moved on the shaft. Pull the pedal up past its normal position, press the pedal down, making sure that the lock is fully engaged, then move the pedal on the shaft until it contacts the step plate. Tighten the clamp bolt securely. See Fig. 46.

ASSEMBLING AND INSTALLING THE DIFFERENTIAL LOCK AND LOCK PEDAL HOUSING

1. Assemble the differential pedal housing by reversing the procedure for disassembly. Note the following points:

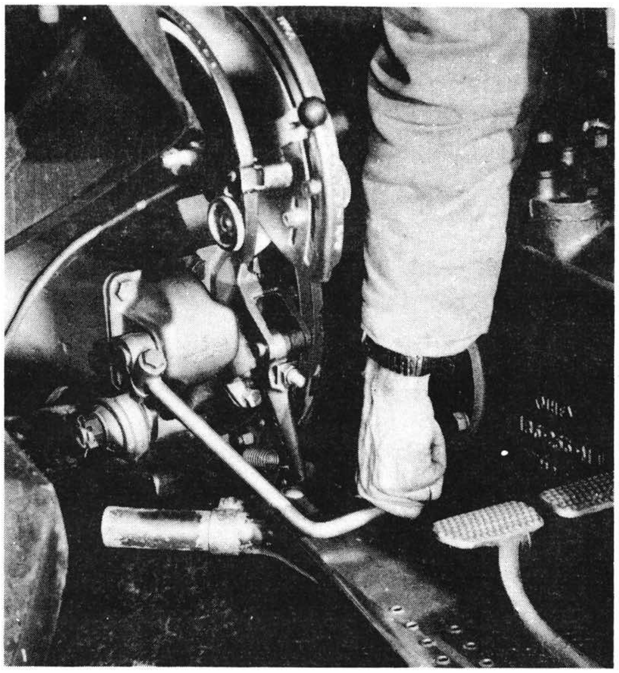

Fig. 46 - Adjusting the Differential Lock

a. The spring is installed on the expansion plug (thrust washer and roll pin) side of the pedal housing.

b. The cam must be on the bearing sleeve side of the housing with the lock screw and nut next to the bearing and the machined boss on the cam towards the differential lock shaft.

c. The recess for the lock screw is in the center of the shaft. This allows the shaft to be installed either end first.

> *NOTE: In the older type housing, install the shaft so that the thrust washer and pin can be installed.*

2. Install:

a. Spring and spring caps in the axle housing.

b. Snap ring in the housing, centered over the hole.

c. Shaft, tapered end first, so that the hole is on top.

> NOTE: Push the shaft in until the snap ring "snaps" into place.

d. Shifter fork and coupler into the differential carrier plate.

e. Brake assembly as outlined in Group IV, Section B, Part 2.

f. Carrier plate, at the same time sliding the shifter fork onto the lock shaft.

g. Roll pin securing the differential lock shifter fork to the differential lock shaft.

h. Allen head screws securing the carrier plate to the housing.

> *NOTE: Tighten the screws at 10 - 12 ft.-lbs. torque.*

i. Lock pedal and cam housing to the axle housing.

> *NOTE: Tighten the bolts to 35 ft.-lbs. torque.*

j. Axle housing and shaft as outlined on Page 5.

k. Cover and wheel axle assembly.

SERVICING THE PINION

REMOVING THE PINION

1. Remove the following:

a. Left-hand rear axle housing and shaft. Lift out the differential assembly.

b. Lift forks, seat and control beam.

c. Hydraulic lift cover, see Group III, Section A, Part 1.

d. Rear drive shaft, rear drive shaft coupler and hydraulic pump.

e. Spiral snap ring (No. 13, Fig. 47) which secures PTO drive gear to PTO drive gear hub and remove drive gear.

f. Bearing cup housing by inserting two bolts in the threaded holes of the housing, pushing out the housing assembly as shown in Fig. 48.

DISASSEMBLING THE PINION

1. Unlock tab-washer (No. 10) and remove lock nut (No. 11), tab-washer, PTO drive gear hub (No. 9), tapered bearing (No. 8) and bearing cup housing (No. 6, Fig. 47).

2. Removing:

a. Pinion inner tapered bearing (No. 4, Fig. 47). See Fig. 49.

b. Pinion pilot bearing snap ring (No. 1) and pilot bearing (No. 2, Fig. 47). See Fig. 50.

c. Bearing cups from the bearing cup housing. See Fig. 51.

ASSEMBLING THE PINION

1. Press the pilot bearing onto the pinion with the chamfered side (see inset, Fig. 52) towards the bevel gear.

2. Install the inner tapered bearing, bearing cup housing, outer tapered bearing, gear hub, tab-washer and lock nut on the pinion shaft. See Fig. 53.

> *NOTE: Be sure to refer to transmission serial number whenever replacing the pinion bearing cups, pinion bearing cup housing and tapered bearings. See page 14.*

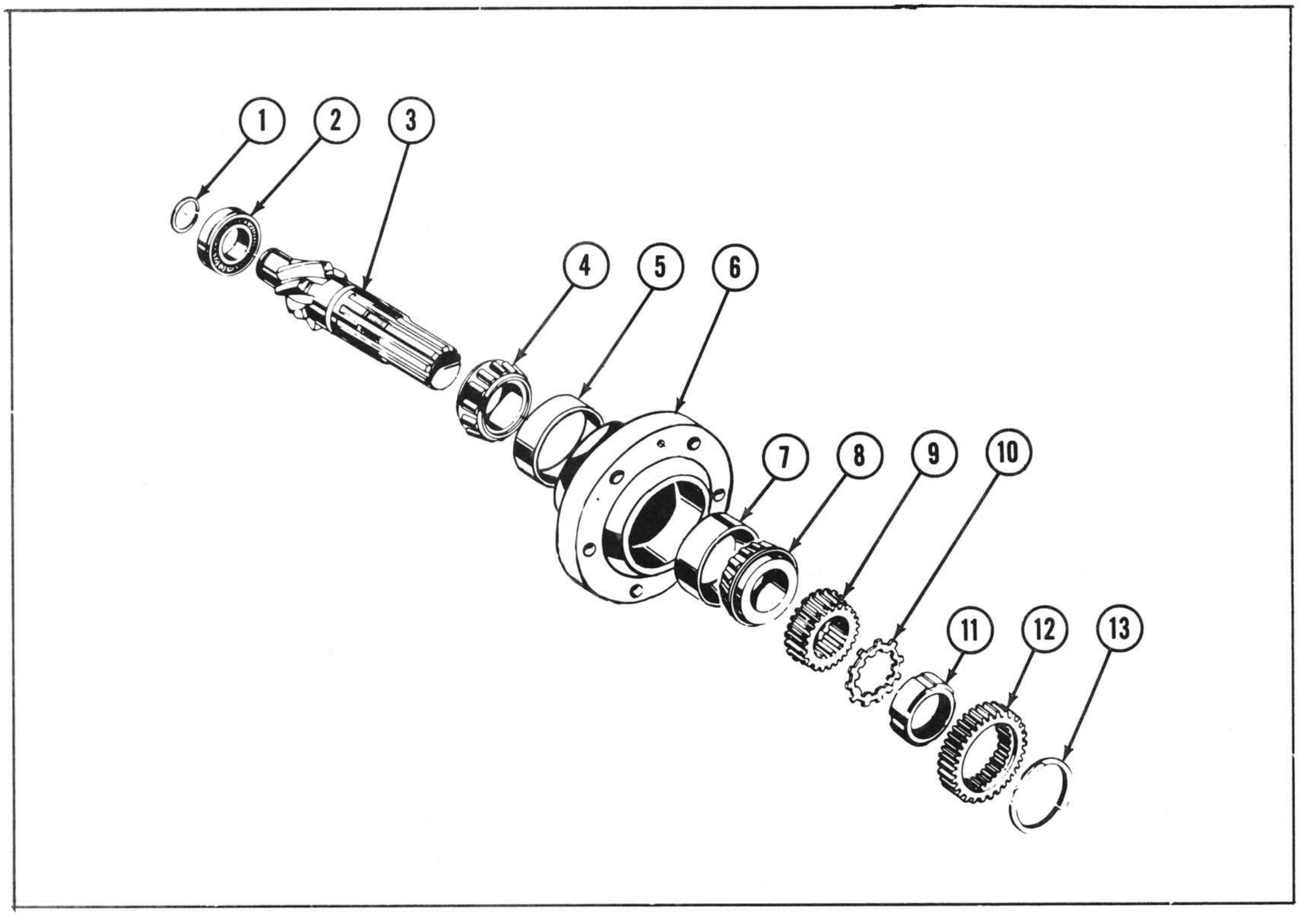

Fig. 47 - Pinion Shaft Assembly

1. Snap Ring
2. Pinion Pilot Bearing
3. Drive Pinion Shaft
4. Inner Tapered Bearing
5. Bearing Cup
6. Bearing Cup Housing
7. Bearing Cup
8. Outer Tapered Bearing
9. PTO Drive Gear Hub
10. Tab Lock Washer
11. Lock Nut
12. PTO Drive Gear
13. Spiral Snap Ring

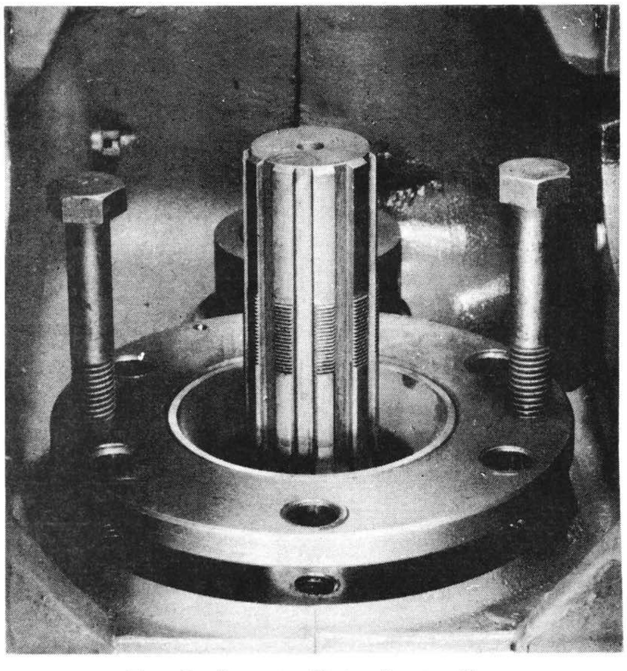

Fig. 48 - Removing Pinion Bearing Sleeve

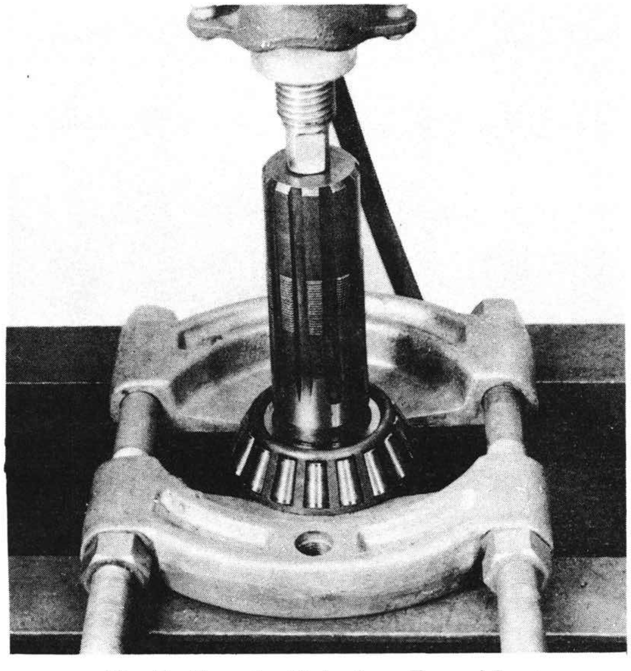

Fig. 49 - Removing Pinion Inner Tapered Bearing

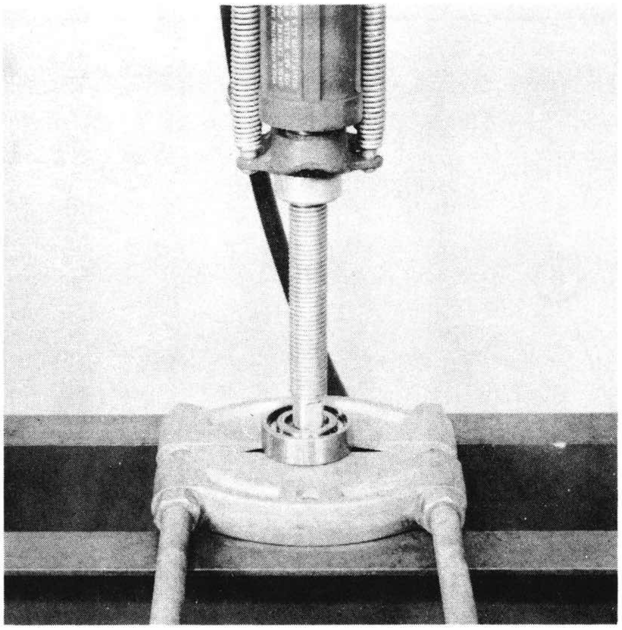

Fig. 50 - Removing Pinion Pilot Bearing

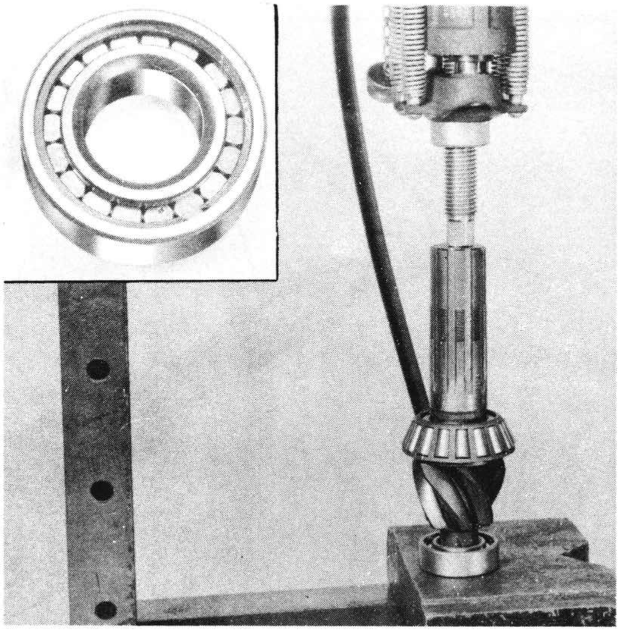

Fig. 52 - Installing Pinion Pilot Bearing

3. With the assembly mounted as shown in Fig. 54, tighten lock nut securely.

4. Back off the lock nut and draw up until a torque loading of 18 - 22 in.-lbs. is required to turn the shaft.

NOTE: This is not the torque loading on the nut, but is the torque required to turn the shaft after the locknut has been tightened. Fig. 54 shows a spanner with a hole drilled at exactly 3 inches from the center of the pinion shaft. With a spring scale attached to this point, it requires 6 to 7-1/4 pounds pull to equal 18 - 22 in.-lbs. torque.

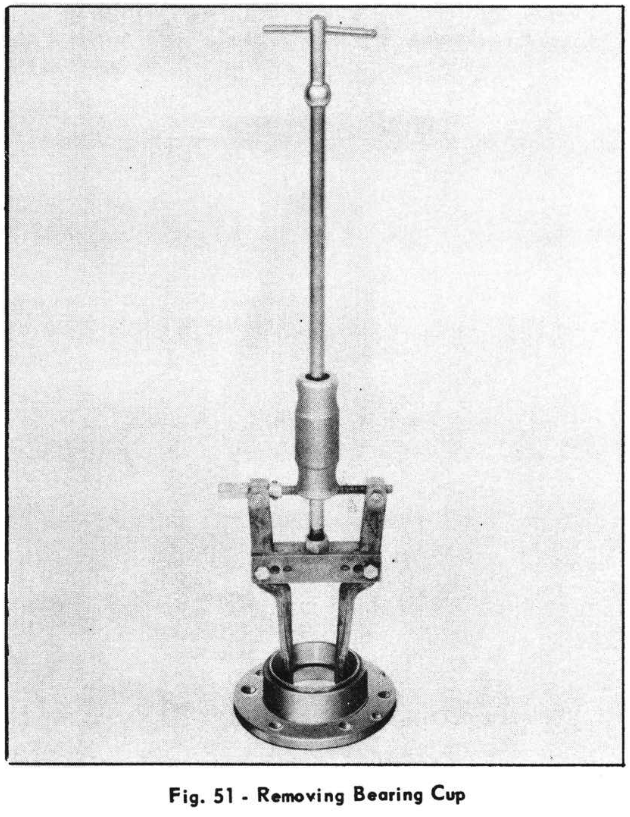

Fig. 51 - Removing Bearing Cup

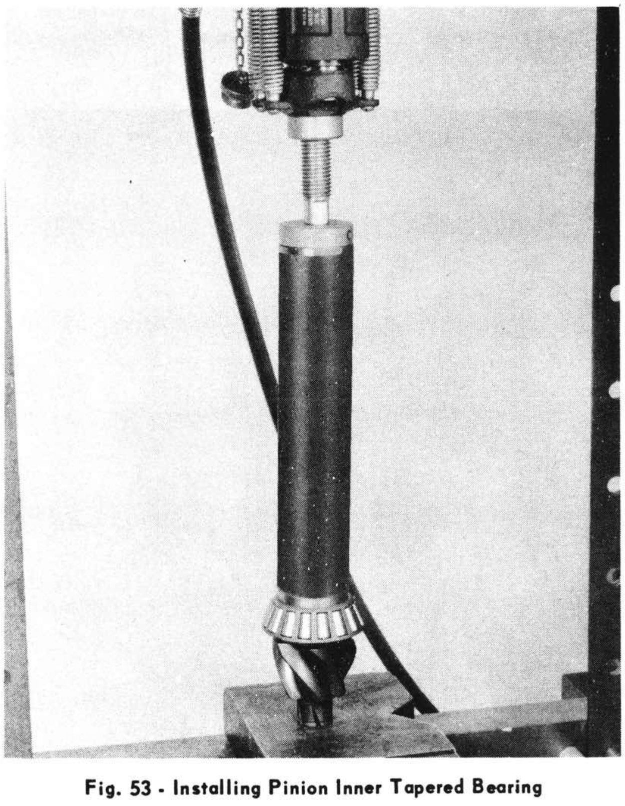

Fig. 53 - Installing Pinion Inner Tapered Bearing

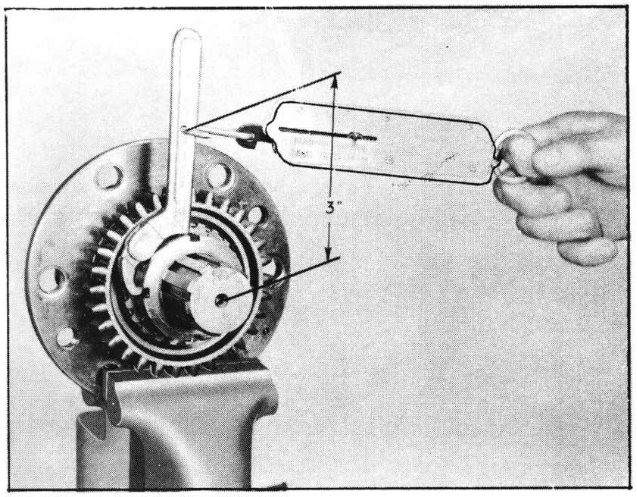

Fig. 54 - Adjusting Pinion Shaft Preload

5. Install ground speed PTO drive gear and spiral snap ring.

INSPECTING AND SERVICING THE PINION

1. Inspect:

a. Pinion and PTO drive gears for damage or wear.

b. Bearing cups for pitting and damage.

c. Bearings for wear and freedom of movement.

2. Replace all parts below minimum specifications.

INSTALLING THE PINION ASSEMBLY

1. Install:

a. Pinion assembly, drawing it into the housing with the retaining bolts.

NOTE: Tighten the bolts to 70 ft.-lbs. torque.

b. Differential assembly and left axle shaft and housing.

NOTE: Install the differential assembly so that the ring gear is on the left side.

c. Hydraulic pump, rear drive shaft and rear drive shaft coupler.

NOTE: The rear drive shaft coupler has two grooves.

d. Hydraulic lift cover, standpipe and transfer plate.

NOTE: Be sure to use new "O" rings and gaskets.

e. Lift forks, control beam and seat.

DIFFERENTIAL , TRANSMISSION AND HYDRAULIC SYSTEM LUBRICATION

The oil used in the hydraulic system lubricates the transmission and differential also.

Capacity of these combined units is 8 U.S. (6-1/2 Imperial) gallons. Oil specifications are:

S.A.E. 90 for temperatures above 50°F.
S.A.E. 80 for temperatures below 50°F.

Additional oil must be added if the requirements of an external hydraulic system are greater than 1-1/2 gallons. Drain the additional oil if the external hydraulic system is disconnected.

GROUP IV — SECTION B — PART 2

PART 2. BRAKES - MF 65 TRACTOR

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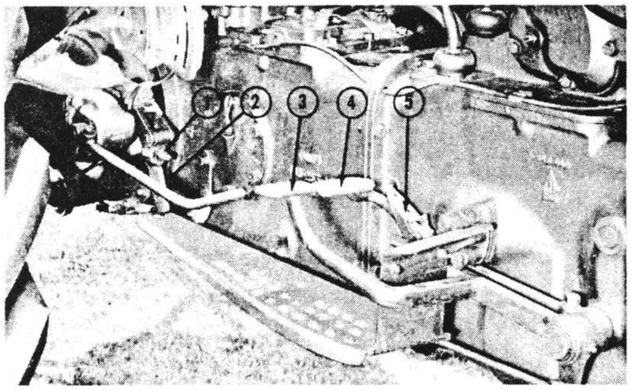

Fig. 1 – Brake Linkage Nomenclature

1. Adjusting Nut
2. Brake Actuating Lever
3. Right Brake Pedal
4. Left Brake Pedal
5. Parking Brake Latch

The MF 65 is equipped with two seven-inch diameter double-disc brakes fitted internally in the inner end of the rear axle bell housing and separated from the differential housing by a carrier plate interposed between the two. See Fig. 1.

One surface of this carrier plate and one surface of the axle housing are machined and serve as stationary housings for the brake. The brakes are mechanically activated and, by means of servo action, the momentum of the tractor is utilized to obtain high braking torque with low pedal effort. The linings are riveted to the discs and are approximately 3/16 inch thick for long service life. Each wheel can be braked independently by pedals mounted on the right-hand side of the transmission housing.

Each pedal is mounted on the brake cross-shaft. The individual brake rods are connected to the brake pedal and to the respective brake actuating lever. The right and left pedals brake the right and left wheel respectively. An interlocking latch locks the pedals together for a master brake. A spring-loaded pawl on the left pedal locks the left brake (or both brakes if the pedals are locked together) in an engaged position.

SERVICING THE BRAKES

ADJUSTING THE BRAKES

When adjusting the MF 65 brakes, always jack up both rear wheels of the tractor and adjust the pedals independently.

> *NOTE: The pedals must both engage and release at the same time and pedal height. This may be adjusted by screwing the brake rod yoke on (or off) the brake rod, thus changing the length of the brake rod.*

Tighten (or loosen) the adjusting nut (No. 1, Fig. 6) on each respective brake rod.

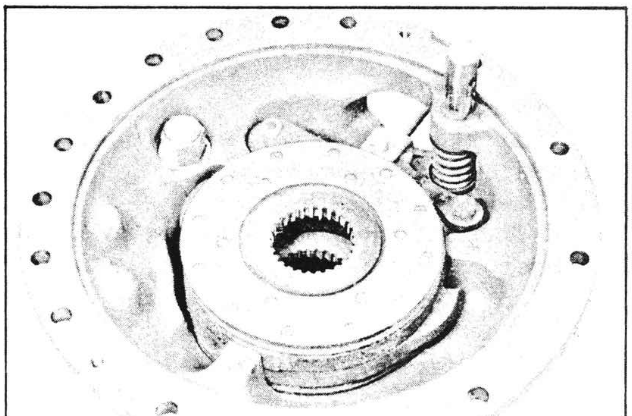

Fig. 2 – Brake Assembly Installed

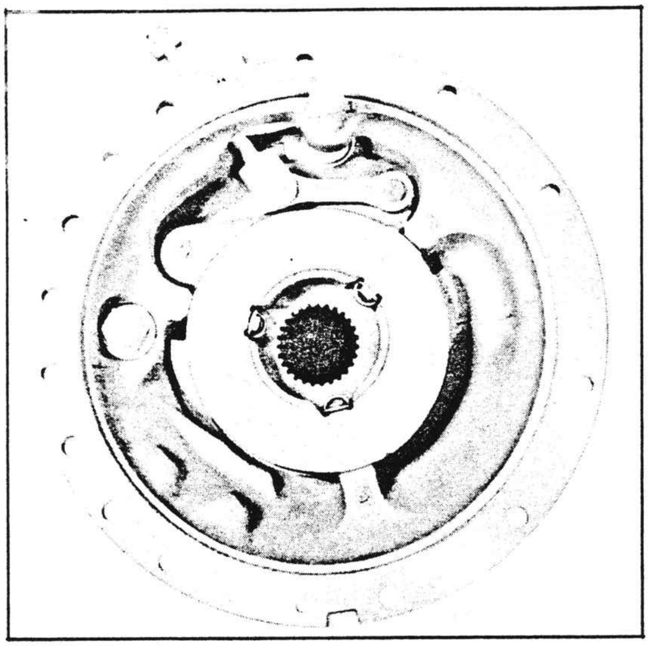

Fig. 3 – Brake Actuating Disc Installed

NOTE: The brakes are properly adjusted when there is 2-1/2 to 3 inches of free-travel in each brake pedal. See Fig. 6.

Always lock the brake pedals together as a master brake and test the "straight-line stoppage" of the tractor after each brake adjustment.

REMOVING THE BRAKE ASSEMBLIES

1. Drain the transmission and differential.

2. Jack up the tractor and remove the rear wheels.

3. Disconnect or remove:

a. The stepboards.
b. The brake rods at the rear clevis.
c. The brake lever springs.
d. The exhaust pipe.
e. The adjusting nut from the brake pull rod.
f. The brake lever support from the axle housing.
g. Nuts securing the rear axles to the center axle housing. Remove the rear axle assemblies.

4. With the axle turned on end, remove the Allen head screws securing the differential carrier plate to the axle housing. Remove the differential plate, lifting carefully over the splines to avoid damaging the oil seal.

NOTE: On the right hand side of differential lock tractors, it is also necessary to drive out the roll pin securing the shifter fork to the differential lock shaft. Lift the shifter fork and coupler with the plate.

5. Lift out the brake assemblies with the friction discs, noting the position of the friction discs, in order that they can be replaced in the same relative positions. See Figs. 2 and 3.

DISASSEMBLING THE BRAKE ASSEMBLY

1. Remove the following:

a. Cotter pin and clevis pin securing the link yoke to the brake pull-rod assembly.

b. Three pull-off springs (collect the five steel balls). See Figs. 4 and 5.

INSPECTING THE BRAKE ASSEMBLY

1. Inspect:

a. Middle disc assemblies for damage. Look for linings which are cracked, glazed or worn down to the rivet heads, and broken or loose rivets.

b. The splines, in both middle disc assemblies and on the shaft, for wear.

c. The pull-off springs between the actuating discs for sufficient tension.

d. All the bolts and pins for wear.

2. Replace all of the above parts not meeting minimum specifications.

NOTE: Do not allow oil to come in contact with the brake linings.

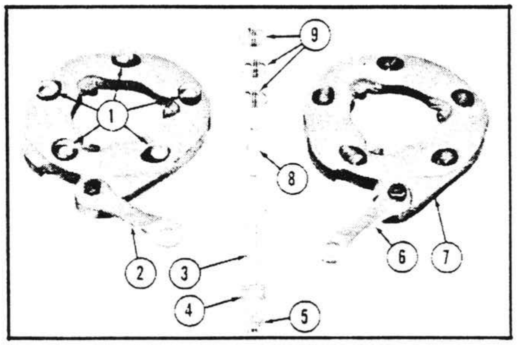

Fig. 4 – Brake Actuating Disc Assembly

1. Steel Balls
2. Link Yoke
3. Brake Rod
4. Adjusting Block
5. Adjusting Nut
6. Link
7. Actuating Disc
8. Clevis Pin
9. Pull-Off Springs

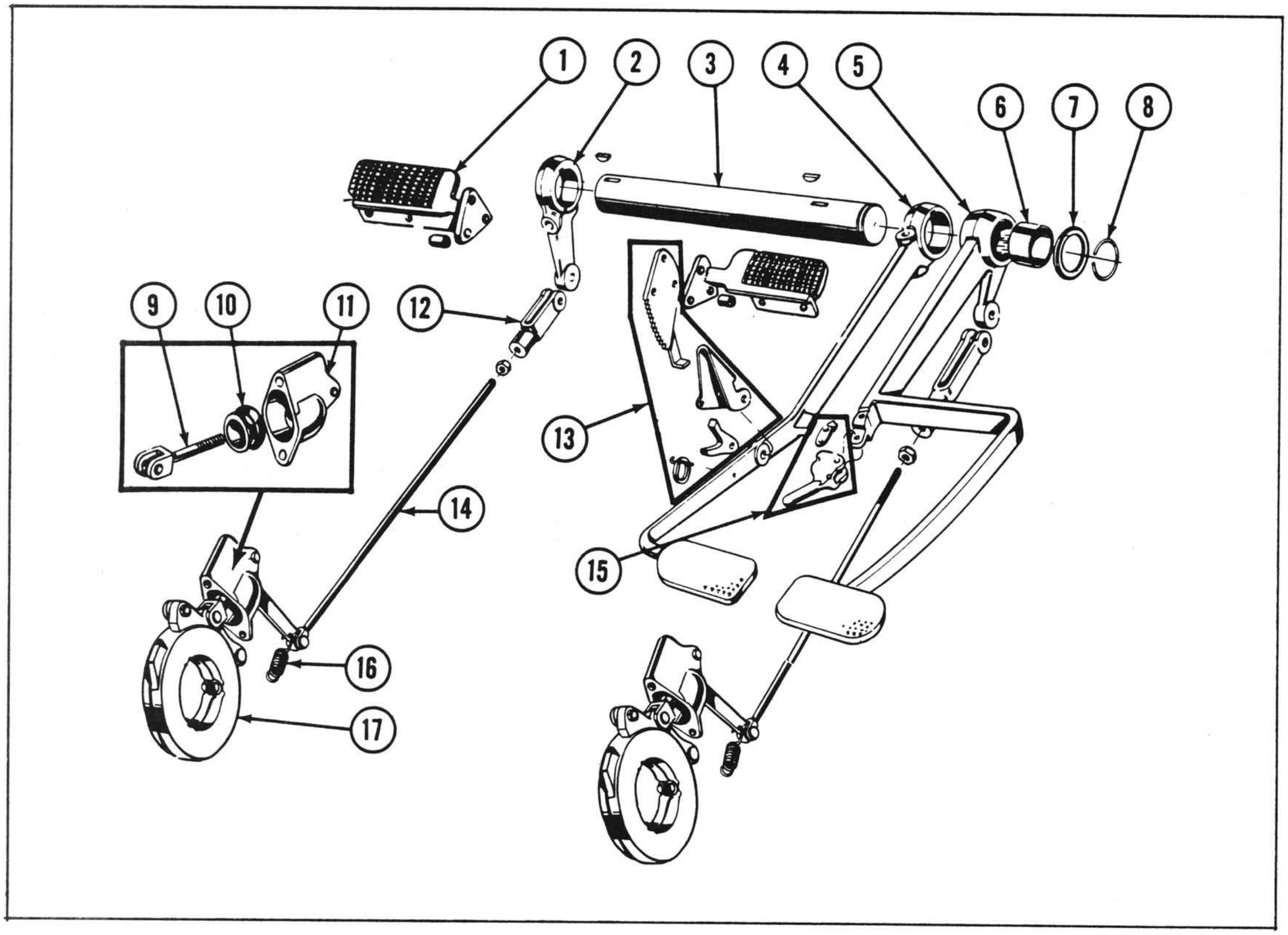

Fig. 5 – Brake System Nomenclature

1. Foot Rest
2. Cross Shaft Arm
3. Cross Shaft
4. Left Brake Pedal
5. Right Brake Pedal
6. Right Pedal Bushing
7. Thrust Washer
8. Snap Ring
9. Brake Rod
10. Dust Cover
11. Brake Lever Support
12. Brake Rod Yoke
13. Parking Latch Assembly
14. Brake Connecting Rod
15. Brake Pedal Lock Assembly
16. Return Spring
17. See Fig. 4

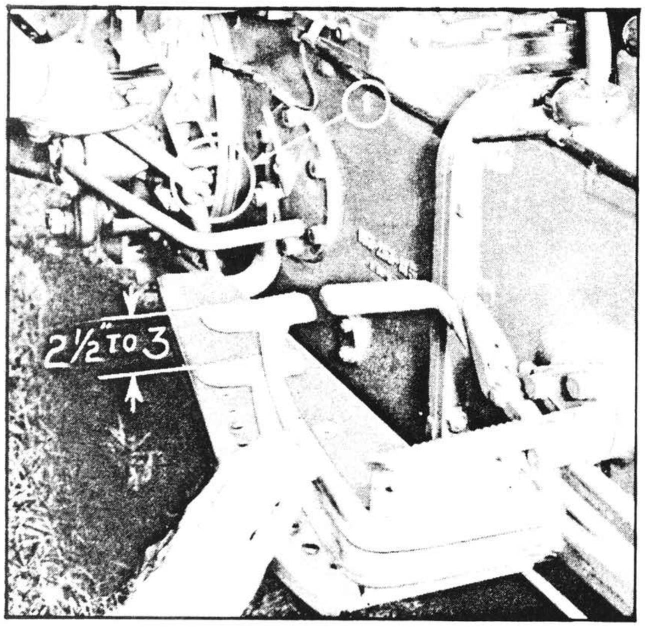

Fig. 6 – Adjusting Pedal Free-Travel

1. Adjusting Nut

ASSEMBLING THE BRAKE ASSEMBLY

1. Lay one actuating disc down, with the ball seats up. Put the balls in the seats.

2. Place the other actuating disc on top, ball seats down, with the lug, to which the link is attached, on the right of the corresponding lug on the other actuating disc.

NOTE: Make sure that the balls are seated in the upper actuating disc.

3. Hook on the pull-off springs.

4. Connect both links to the yoke. Insert the clevis pin and a new cotter pin.

NOTE: If any portion of the yoke assembly has been renewed, necessitating the removal of the studs and jam nuts, these nuts must be tightened to a torque of 18 ft.-lbs. on assembly.

INSTALLING THE BRAKE ASSEMBLIES

1. Set the middle discs and the actuating assembly in their original positions with the yoke of the actuating assembly in line with the hole through which the operating rod will pass.

2. Install the differential carrier plate carefully over the splines of the axle shaft and secure with Allen head screws. Tighten the screws to 10 - 12 ft.-lbs. torque.

> *NOTE: On the right hand side of tractors equipped with the differential lock, install the following.*

a. The differential lock coupler, shifter fork and carrier plate.

> *NOTE: Secure the differential carrier plate to the axle housing with the Allen head screws. Tighten the screws to a torque of 10 - 12 ft.-lbs.*

b. The roll pin through the differential lock shifter fork and shaft.

3. Connect the brake lever support bracket with the lever attached to the axle housing. Tighten the bolts to a torque of 35 ft.-lbs.

4. Connect the rod assembly to the lever and secure with the spacer and adjusting nut.

5. Install the axle housing on the tractor and connect the brake rods, the brake lever springs, the exhaust pipe, etc. Install the wheels.

6. Adjust the brakes.

GROUP II — SECTION D — PART 1

POWER TAKE-OFF SHAFT ASSEMBLY

35, 50 AND 65 (MF & TO) TRACTORS

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The power take-off shaft, shown in Fig. 1, projects from the rear of the tractor center housing and has a 1-3/8 inch spline with an annular groove for positive connection of implement couplings.

A removable cap protects the splines when the shaft is not in use. The shaft itself is supported at the rear by a ball bearing and at the front by a needle roller bearing. The pilot on the front of the PTO shaft inserts into a needle bearing in the hydraulic pump thus supporting the rear of the pump. Double seals keep dirt out of the bearing and prevent oil from leaking out of the differential center housing. The power take-off is engaged by a lever, located on the left side of the tractor center housing, which selects either proportional engine speed or proportional ground speed. The lever also has a neutral position which disconnects the drive.

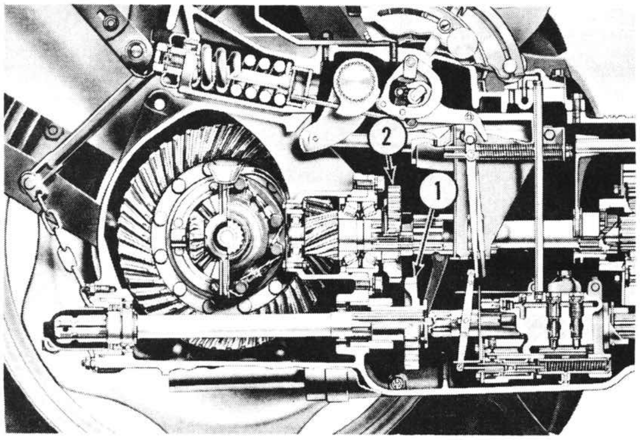


Fig. 1 – PTO Shaft

1. PTO Ground Speed Drive Gear 2. PTO Ground Speed Driven Gear

LIVE PTO

The deluxe tractor is fitted with dual clutch and live PTO. The PTO drive from the engine is controlled by the clutch pedal in the bottom half of its range. The initial movement of the clutch disengages the transmission only; additional downward movement disconnects the hydraulic pump and PTO shaft. On the basic tractor the hydraulic pump and PTO shaft and transmission are driven directly by the transmission countershaft, and on the deluxe tractor by a drive shaft which passes through a hollow countershaft assembly, and is therefore independent of the transmission. (See also Clutch and Transmission Sections of this Service Manual.)

ADVANTAGES OF THE LIVE PTO

Live PTO allows such machines as a baler or combine to operate continuously without being affected by the tractor stopping and starting, and enables the operator to halt the tractor's forward motion, permitting the combine or baler to clear a particularly heavy stand of grain or roughage. Moreover, since the PTO drive shaft rotates the hydraulic pump, the operator, when using a manure loader, will be able to have continuous control over the fork height without having to select neutral gear to maintain the drive to the pump.

PROPORTIONAL ENGINE SPEED

The proportional engine speed drive of the PTO is selected by pulling the shift lever upward to engage the internal splines of the ground PTO driven gear (No. 1 Fig. 1) with the splines on the rear end of the hydraulic pump drive shaft. The PTO is driven at 18/50 of the engine r.p.m. It should be noted that the PTO shaft is coupled behind the hydraulic pump shaft, the pump is therefore constant running and continues to operate even when the PTO is disengaged.

PROPORTIONAL GROUND SPEED

The proportional ground speed drive PTO is engaged by pushing the shaft lever downward (toward the ground) thereby shifting the ground PTO driven gear (No. 1, Fig. 1) into mesh with the gear (No. 2, Fig. 1) splined to the rear axle driving pinion. The PTO shaft speed is then related to the ground speed of the tractor and the shaft revolves once for

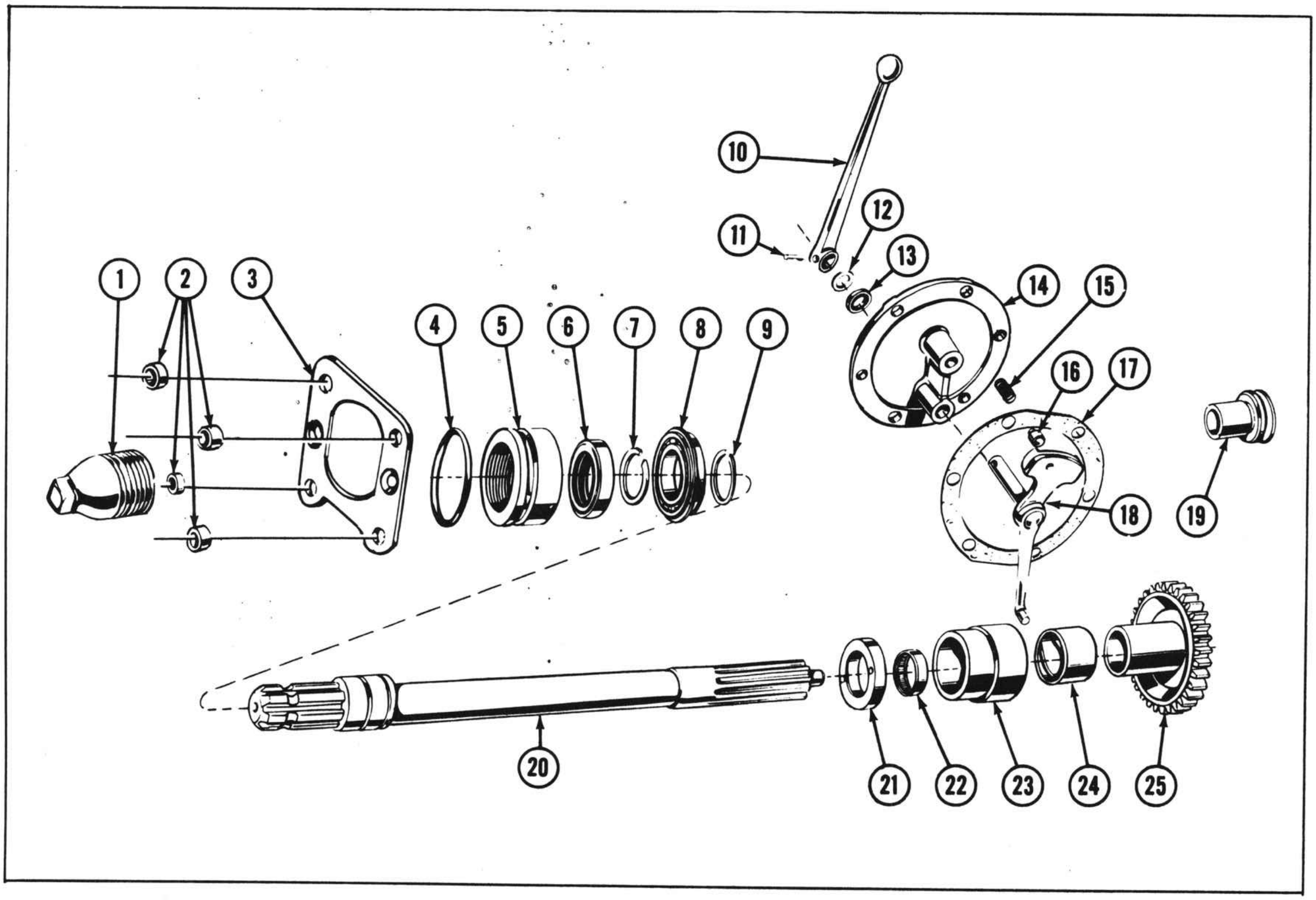


Fig. 2 – PTO Nomenclature

1. Cap
2. Spacers
3. Retainer Plate
4. "O" Ring
5. Seal Retainer
6. Oil Seal
7. Snap Ring
8. Bearing
9. Snap Ring
10. Shift Lever
11. Roll Pin
12. Flat Washer
13. Oil Seal
14. Side Cover
15. Plunger Spring
16. Fork Plunger
17. Gasket
18. Shift Fork
19. Drive Hub*
20. PTO Output Shaft
21. Bearing Retainer
22. Needle Bearing
23. Shaft Sleeve
24. Sleeve Bushing
25. Ground Speed Driven Gear

*Replaces No. 25 on tractors not having ground speed PTO.

approximately every 19 inches of travel by the rear wheels.

> *NOTE: If the tractor is reversed, the direction of rotation will also be reversed. Many implements will be damaged if operated in reverse.*

SERVICING THE OUTPUT SHAFT ASSEMBLY

REMOVING THE OUTPUT SHAFT

1. Drain the oil from the differential center housing.
2. Remove the nuts and spacers (No. 2) check chain brackets and the retaining plate (No. 3, Fig. 2) from the rear center housing.
3. Pull the shaft (No. 20). seal retainer (No. 5), seal (No. 6) and rear bearing (No. 8, Fig. 2) as an assembly from the rear of the tractor as shown in Fig. 3.

DISASSEMBLING THE OUTPUT SHAFT

Remove the following:

a. The oil seal retainer (No. 5, Fig. 2) from the output shaft.

b. The "O" ring (No. 4, Fig. 2) from around the oil seal retainer.

c. The oil seal (No. 6, Fig. 2) from the retainer.

d. The snap rings (Nos. 7 and 9, Fig. 2).

e. The Bearing (No. 8, Fig. 2) as shown in Fig. 4.

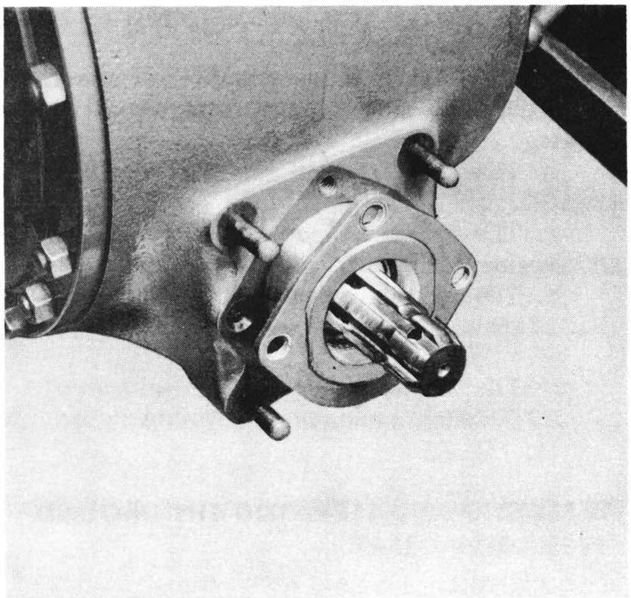


Fig. 3 – Removing Output Shaft

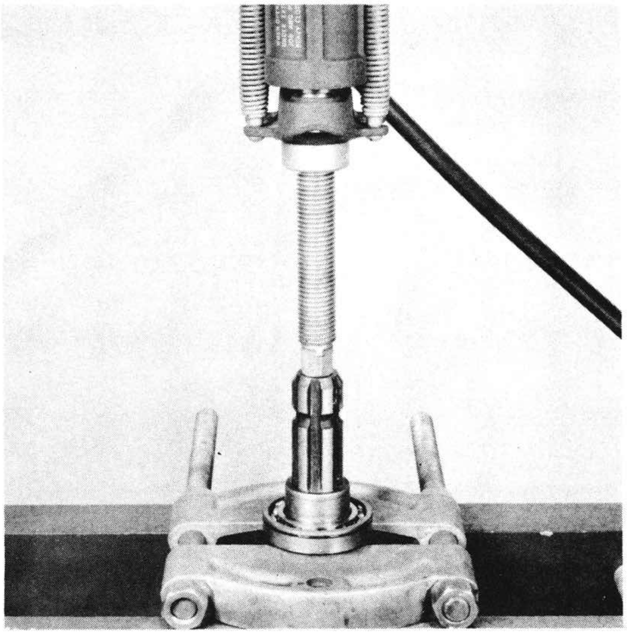


Fig. 4 – Removing Rear Support Bearing

INSPECTING AND SERVICING THE OUTPUT SHAFT ASSEMBLY

Inspect the following and replace if necessary.

a. The shaft splines for distortion and damage.

b. The "O" ring, from around the seal retainer, for damage.

c. The oil seal for damage and signs of leaking.

d. The bearing for damage, pitting, freedom of movement and excessive wear.

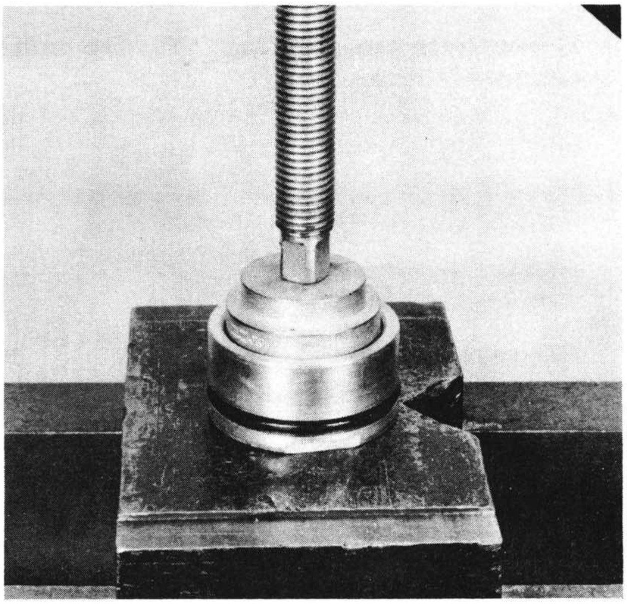


Fig. 5 – Installing Oil Seal

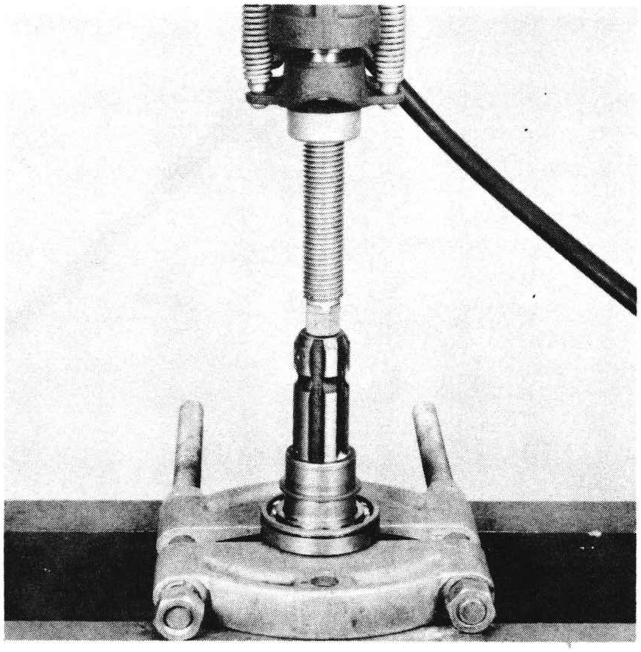


Fig. 6 – Installing Rear Support Bearing

ASSEMBLING THE OUTPUT SHAFT

1. Using a press, replace the oil seal into the retainer as shown in Fig. 5.
2. Install snap ring (No. 7, Fig. 2) on the output shaft.
3. Install the shaft into the bearing as shown in Fig. 6. Press the shaft in and install snap ring (No. 9, Fig. 2).
4. Lubricate the chamfered edge (No. 1, Fig. 7) and carefully work the lubricated oil seal and retainer onto the shaft.

INSTALLING THE OUTPUT SHAFT

1. Lubricate the retaining "O" ring with a good grade of brake fluid.

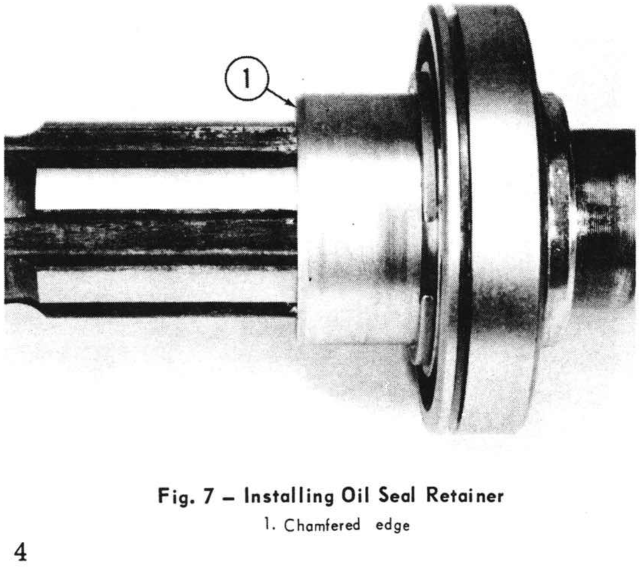


Fig. 7 – Installing Oil Seal Retainer
1. Chamfered edge

2. Position the "O" ring (No. 4, Fig. 2) onto the oil seal retainer.
3. Install the output shaft from the rear of the tractor.

> *NOTE: Use care so the "O" ring and oil seal are not damaged during installation. If the hydraulic pump is in place, loosen the dowel pins and guide the pilot into the needle bearings.*

4. Replace the retainer plate and check chain brackets. Tighten the nuts to a torque of 35 ft.-lbs.

> *NOTE: On MF 65 Tractors, tighten the Allen head set screws in the retainer plate to a torque of 35 ft.-lbs.*

5. Align the hydraulic pump as outlined in Group III, Section A, Part 1 and tighten the dowel pins.

SERVICING THE GROUND SPEED PTO DRIVE GEARS

REMOVING THE GROUND SPEED DRIVE GEARS

Remove the following:

a. The hydraulic lift cover as outlined in Group III, Section A, Part 1.
b. the cotter pin from the rear drive shaft coupler.
c. the rear drive shaft and coupler.
d. the spiral snap ring and the ground speed PTO drive gear pinion from its hub on the pinion gear shaft.
e. the PTO shift lever and cover assembly from the left side of the differential center housing.
f. The PTO output shaft as outlined on Page 3.
g. The hydraulic pump as outlined in Group III, Section A, Part 1.
h. The ground speed PTO gear (No. 25, Fig. 2) from the sleeve bushing.

> *NOTE: Tractors without ground speed PTO drive, remove the drive hub (No. 19, Fig. 2).*

INSPECTING AND SERVICING THE GROUND SPEED DRIVE GEARS

1. Inspect the gears for damaged teeth. Replace if necessary.

NOTE: Backlash between the ground speed PTO gears (Nos. 1 and 2, Fig. 1), when installed and meshed, shall be 0.002 to 0.008 inch.

2. Inspect the needle bearing (No. 22, Fig. 2) for excessive wear and freedom of movement. Replace if necessary.
3. Inspect the bushing (No. 24, Fig. 2) for excessive wear. Replace if necessary.

INSTALLING THE GROUND SPEED DRIVE GEARS

Install the ground speed PTO drive gears by reversing the procedure outlined for removal.

NOTE: To provide tractors, not so equipped, with ground speed PTO drive, replace the drive hub (No. 19) with the drive gear (No. 25, Fig. 2).

SERVICING THE FRONT OUTPUT SHAFT SUPPORT ASSEMBLY

REMOVING THE FRONT OUTPUT SHAFT SUPPORT

1. Remove the following:

a. The hydraulic lift cover. See Group III, Section A, Part 1.
b. The rear drive shaft and coupler.
c. The PTO output shaft as outlined on Page 3.
d. The hydraulic pump. See Group III, Section A, Part 1.
e. The left axle shaft and housing. See Group II, Section C.
f. The differential unit. See Group II, Section C.

2. Using step plate and driver, drive out the needle bearing and retainer as a unit as shown in Fig. 8.
3. Remove the PTO shaft sleeve from the front by using a step plate and driver through the rear of the differential center housing.

DISASSEMBLING THE FRONT OUTPUT SHAFT SUPPORT

Press out the following:

a. Sleeve bushing from the sleeve.
b. The needle bearing from the retainer.

INSPECTING AND SERVICING THE FRONT OUTPUT SHAFT SUPPORT

Examine the parts of the front output shaft support for damage and excessive wear. Check the needle bearing.

ASSEMBLING THE FRONT OUTPUT SHAFT SUPPORT

1. Press the needle bearing in until it is flush with one side of the retainer.

NOTE: Always press (or drive) against the lettered side of a needle bearing.

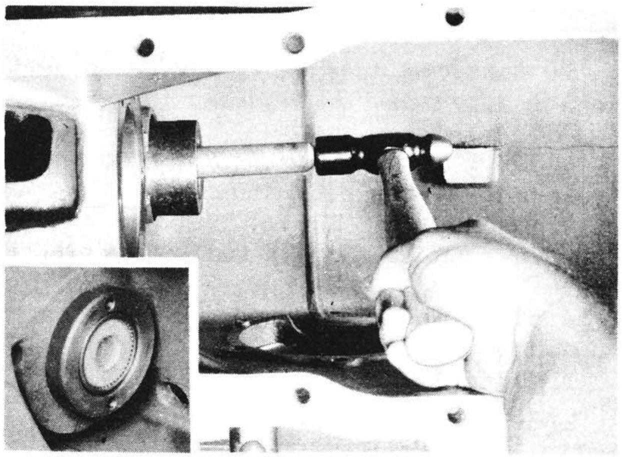
2. Align the locking lip with the lip slot in the sleeve and press the bushing in until it is flush with the face of the sleeve.

INSTALLING THE FRONT OUTPUT SHAFT SUPPORT

1. Drive the sleeve in from the front until the shoulder seats against the housing.
2. Position the holes in the needle bearing retainer at top and bottom and drive the retainer in from the rear of the center housing. See Fig. 9.

NOTE: Drive the retainer in until it is flush with the face of the bore in the differential center housing.

3. Complete installation by reversing "a" through "f" of Step 1 in "Removing the Front Output Shaft Support".



• Fig. 8 – Removing Front Support Bearing Retainer

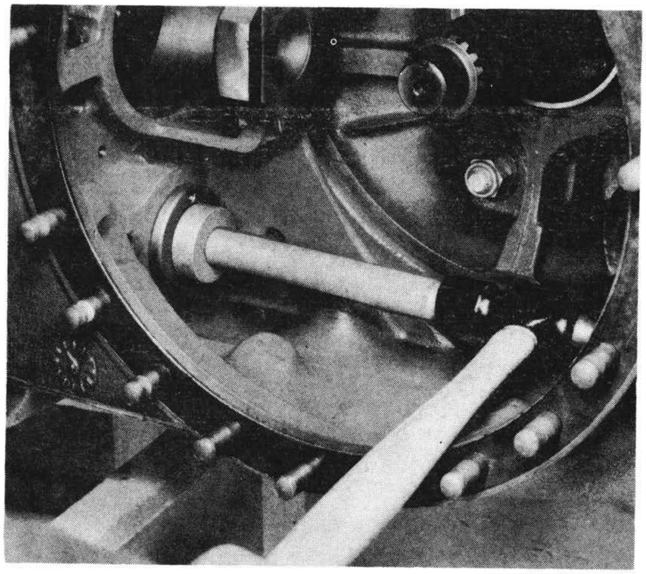


Fig. 9 – Installing Front Support Bearing Retainer

SERVICING POWER TAKE-OFF SHAFT EXTENSION ASSEMBLIES

When using the Massey-Ferguson tractor with most pull-type power take-off operated equipment, adapter kits and shields will be necessary to convert the tractor to meet A.S.A.E. requirements for a standard hitch.

The extensions are available in three lengths for the 35 and 50 (MF and TO) tractors and in one length for the MF 65 tractor. Length selection is based upon the distance from the center of the drawpin hole to the end of the PTO shaft. This distance must not be greater than 14 inches.

Removal and installation of the various extensions is quite evident, therefore, only the disassembly, inspecting, servicing and assembly of these units will be covered.

DISASSEMBLING THE SHAFT EXTENSIONS

To disassemble the shaft extension, as shown in Fig. 10, remove the following:

1. Bolts attaching extension housing to the rear of the tractor center housing.
2. Coupling pin (No. 8). Remove the extension coupling (No. 7) and spacer (No. 6).
3. Snap ring (No. 2).
4. Shaft (No. 5) and bearing (No. 3) from the housing.
5. Bearing off the shaft with a press.

Thoroughly clean the parts and examine them for damage and excessive wear. Replace if necessary.

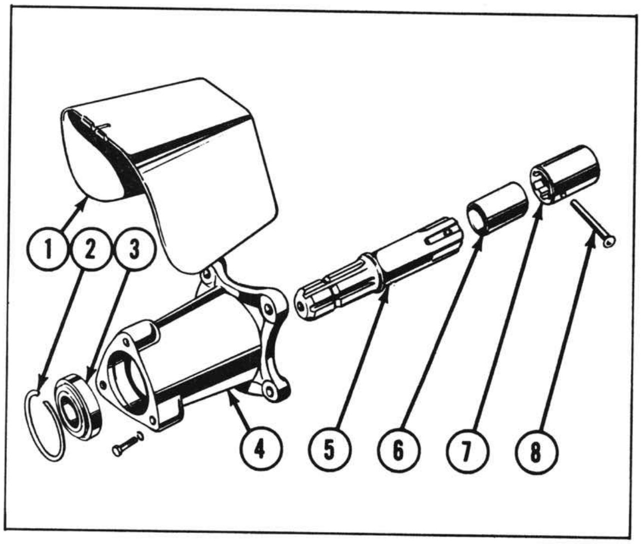


Fig. 10 – PTO Shaft Extension (7–13/16 and 14–1/8 inches)

1. Guard
2. Snap Ring
3. Bearing
4. Extension Housing
5. Extension Shaft
6. Spacer
7. Coupler
8. Coupler Pin

Assemble the shaft extension by reversing the removal procedure.

To disassemble the extension shown in Fig. 11.

1. Remove the bolts attaching the shield (No. 3) to the differential center housing.
2. Take out the lock bolt (No. 2) and slide the extension shaft (No. 1) off the end of the output shaft.

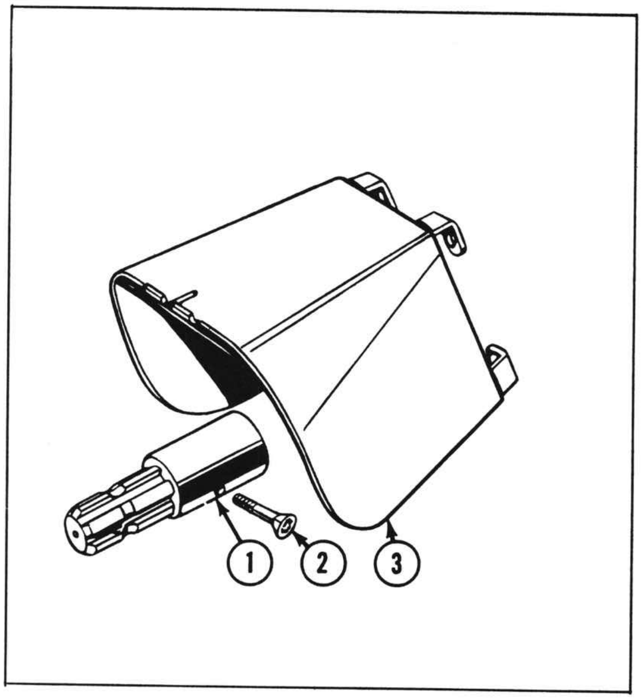


Fig. 11 – PTO Shaft Extension (3–1/2 inches)

1. Shaft Extension 2. Lock Bolt 3. Guard

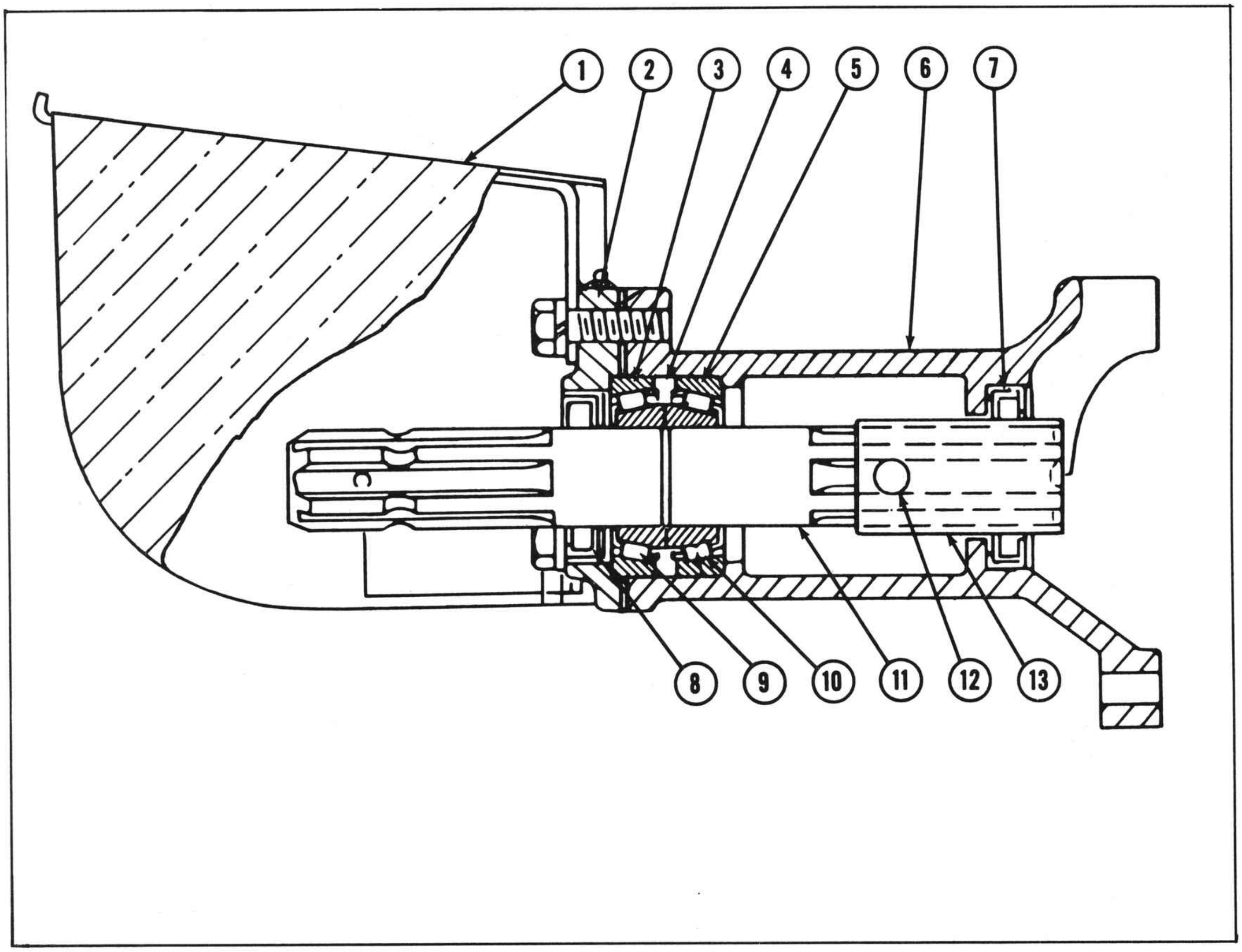


Fig. 12 – PTO Shaft Extension (9 inches)

1. Guard
2. Housing Cover
3. Bearing Cup
4. Lubricant Space
5. Bearing Cup
6. Extension Housing
7. Oil Seal
8. Oil Seal
9. Tapered Bearing
10. Tapered Bearing
11. Extension Shaft
12. Coupling Pin
13. Coupler

Thoroughly clean the parts and examine them for damage and excessive wear. Replace if necessary.

Assemble the shaft extension by reversing the removal procedure.

To disassemble the PTO shaft extension shown in Fig. 12, remove the following:

1. Bolts holding the shield (No. 1) and housing cover (No. 2) in place.

NOTE: Use care when removing the end cap so that the shim pack is not lost or damaged.

2. Bolts holding the extension housing (No. 6) to the differential center housing.
3. Slide shaft (No. 11) from rear side of housing.
4. Coupling (No. 13) from shaft.
5. Oil seals (Nos. 7 & 8) from housing.
6. Tapered bearings (Nos. 9 & 10) from shaft.
7. Bearing Cups (Nos. 3 & 5) from the housing.

Examine the extension shaft assembly components for excessive wear and damage. Check the oil seals for signs of leaking. Inspect the tapered bearings for excessive wear and freedom of movement. Examine the bearing cups for pitting and damage. Replace all parts not meeting minimum standards.

1. To assemble the PTO shaft extension install:

   a. Bearing cup (No. 5) into the housing.

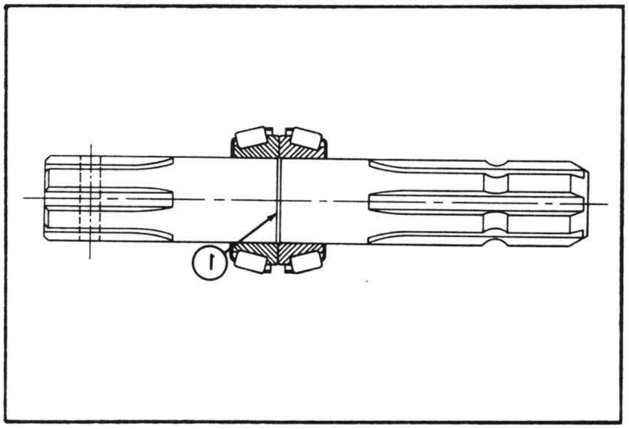


Fig. 13 – Installing the Tapered Bearings
1. Groove

b. Bearing cup (No. 3) into the housing cover.

c. Oil seals (Nos. 7 & 8) into the housing and cover.

d. Bearings (Nos. 9 & 10) onto the shaft. Pack the bearings with ball and roller bearing grease before installation.

NOTE: Position so that bearings are centered over groove as shown in Fig. 13.

e. Coupler (No. 13) onto shaft. Rivet over end of pin.

NOTE: Outside dimension (head to head) must not exceed 2-1/2 inch.

2. Notice the area (No. 4) left between the bearing cups in Fig. 12. Pack this area of the housing with approximately 1/8 lb. of ball and roller bearing grease.
3. Lubricate the oil seals with brake fluid and carefully install the shaft into the housing.
4. Install the original shim pack and start the bearing cup (No. 3) into the housing.
5. Draw the bearing cup into position by pulling the cover into position with the three cap screws. Tighten the cap screws to a torque of 33 to 38 ft.-lbs.

NOTE: It should require 5 to 10 in.-lbs. torque (a slight drag) to turn the shaft in its bearings. To adjust preload, remove shims to increase torque and add shims to decrease torque.

6. Bolt the extension assembly to the differential center housing and install the shield.

PTO SHAFT SPECIFICATIONS CHART

Number of Splines	6
Major Diamters	1.371 - 1.373 (1-3/8) inch
Minor Diameters	1.098 - 1.108 (1-3/32) inch
Width of Splines	0.338 - 0.340 inch
Length Available for Attachments	2.78 inch
Diameter of Holes	21/64 inch
Distance From Hole Center to Shaft Ends	0.625 inch
Minor Diameter of Grooves	1.160 - 1.155 inch
Distance From Groove Center to Shaft End:	1-1/8 inch

PROPORTIONAL ENGINE SPEED CHART

Engine Speed (RPM)	PTO Shaft Speed (RPM)	Pulley Speed (RPM)	Belt Speed (ft./min)
1500	540	1002	2360
2000	720	1340	3148

PROPORTIONAL GROUND SPEED

1 shaft revolution per 19 inches (approximately) of travel of the rear wheels.

GROUP II — SECTION D — PART 3

SERVICING THE BELT PULLEY

35, 50 AND 65 (MF & TO) TRACTORS

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Servicing the 35 & 50 (MF & TO) Belt Pulley and the MF 65 Light-Duty Belt Pulley 1

Servicing the MF 65 Heavy-Duty Belt Pulley 3

SERVICING THE 35 & 50 (MF & TO) BELT PULLEY AND THE MF 65 LIGHT-DUTY BELT PULLEY

The belt pulley is a self-contained attachment mounted to the PTO housing and driven by the PTO shaft. The ratio of speeds of the pulley to the PTO shaft and engine is 1.84 to 1, and 1 to 1.51 respectively.

SELECTING DRIVEN PULLEY DIAMETER

To determine the diameter of the driven pulley, necessary to obtain a given RPM, refer to the right hand side of the table, Fig. 1. Note that there is a choice of pulley sizes for any one pulley rate; however, each size is based on a specific engine RPM. In most cases the engine RPM required to operate the belt equipment will be determined to a large degree by the horsepower or load requirements of the equipment. In general, the greater the load involved, the more horsepower will be required, and consequently a higher engine RPM will be necessary.

CAUTION: To avoid static electricity when using the belt and pulley, ground the tractor by wrapping a chain around the front axle and drop one end on the ground.

Engine RPM	PTO RPM	Pulley RPM	Belt Speed (ft/min)	DRIVEN PULLEY – RPM DESIRED								
				600	800	1000	1400	1800	2200	2600	3000	3400
				DRIVEN PULLEY – DIAMETER NECESSARY								
1000	360	662	1547	10	7½	6	4½	3½				
1200	432	795	1859	12	9	7½	5	4	3½			
1400	504	927	2165	14	10½	8½	6	4½	4	3½		
1500	540	992	2320	15	11	9	6	5	4	3½		
1600	576	1060	2478	16	12	9½	7	5½	4½	3½		
1700	611	1127	2632	17	13	10½	7½	5½	4½	4	3½	
1800	648	1192	2788	18	13½	11	8	6	5	4	3½	
1900	684	1250	2920	19	14½	11½	8	6½	5½	4½	4	3½
2000	720	1325	3097	20	15	12	8½	6½	5	4½	4	3½
2100	756	1391	3253	21	16	12½	9	7	6	5	4½	4

This table is based on an average slippage loss of 3% between the drive and driven pulleys at all speeds. However, it should be noted that as the diameter of a pulley decreases the per cent of slippage will increase; thus pulleys smaller than 3½ in. should not be used unless absolutely necessary.

Fig. 1 – Pulley Diameter Selection Table

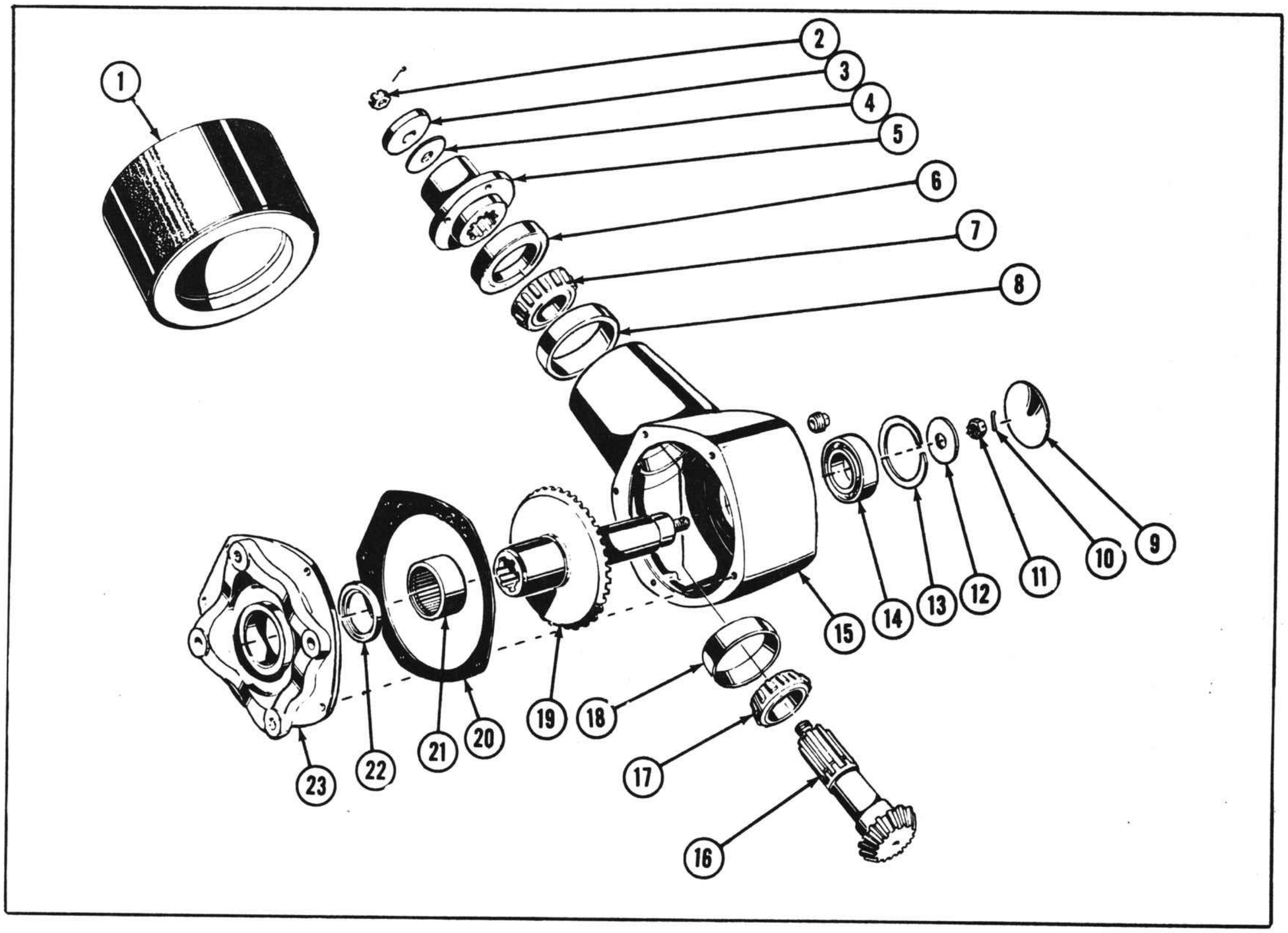

Fig. 2 – Belt Pulley Nomenclature

1. Pulley Assembly
2. Castellated Nut
3. Washer
4. Oil Seal
5. Drive Hub
6. Oil Seal
7. Bearing Cone
8. Bearing Cup
9. Expansion Plug
10. Cotter Pin
11. Castellated Nut
12. Washer
13. Snap Ring
14. Ball Bearing
15. Drive Housing
16. Drive Pinion
17. Bearing Cone
18. Bearing Cup
19. Drive Gear Assembly
20. Gasket
21. Needle Bearing
22. Oil Seal
23. Input Bearing Housing

REMOVING THE BELT PULLEY

Remove the belt pulley as a unit by unscrewing the 4 cap screws securing it to the PTO housing.

DISASSEMBLING THE BELT PULLEY

Refer to Fig. 2, and remove:

1. In put shaft bearing housing, No. 23, from housing assembly, No. 15.
2. Expansion plug, No. 9, from housing assembly, No. 15.
3. Cotter pin, No. 10, nut No. 11 and washer No. 12 from pulley drive gear assembly, No. 19.
4. Pulley drive gear assembly, No. 19, by driving it out of housing.
5. Pulley, No. 1, from hub, No. 5.
6. Cotter pin, nut No. 2, washer No. 3 and seal No. 4 from pulley drive pinion, No. 16.
7. Hub, No. 5, from pulley drive pinion.
8. Pulley drive pinion from housing.
9. Snap ring, No. 13, and ball bearing, No. 14, from housing.
10. Seal, No. 22, from input bearing housing.
11. Needle bearing, No. 21, from pulley drive gear shaft.
12. Oil seal, No. 6, from drive pulley housing assembly.
13. Inner and outer bearing cones, Nos. 17 and 7.
14. Inner and outer bearing cups, Nos. 18 and 8.

INSPECTING THE BELT PULLEY

1. Clean all parts thoroughly and inspect for wear or damage.
2. The drive pinion and gear may be replaced separately. A "matched set" is not required.

ASSEMBLING THE BELT PULLEY

1. Lightly grease the sealing surfaces of oil seals and rotate shafts as they pass through the new oil seals.

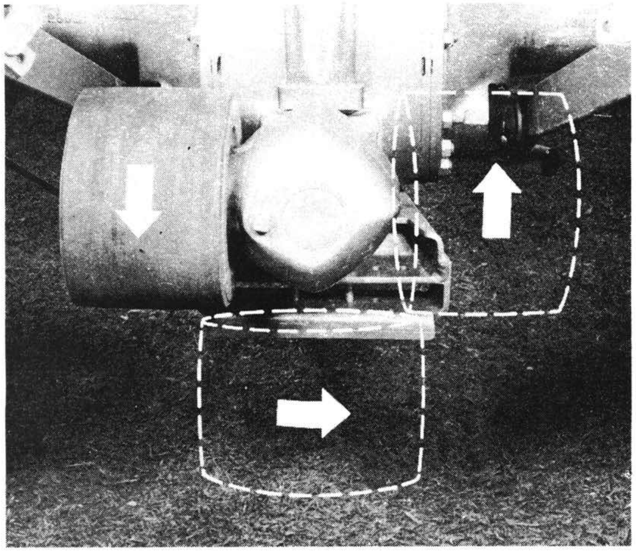

Fig. 3 – Installing the Belt Pulley

2. Reverse the disassembling procedures to assemble the unit.

3. When assembled, tighten nut on pinion shaft until 2-4 inch pounds is required to rotate the shaft, then, back off on the nut until cotter pin can be inserted. Tighten nut on drive gear shaft to adjust the backlash of bevel gears to 0.004-0.006 inch, then, back off on the nut until cotter pin can be inserted.

INSTALLING THE BELT PULLEY

1. Refer to Fig. 3 and prepare tractor for installing belt pulley as follows:

Remove:

a. PTO cap.

b. Check chain anchor brackets.

NOTE: Install the brackets with chains attached to upper holes to prevent restriction of lower links.

2. The belt pulley may be installed in any one of three positions as shown in Fig. 3. Do not install in an "up" position.

3. Install the belt pulley unit to the PTO housing and secure with 4 cap screws.

4. Fill belt pulley gear housing with SAE 80 for winter and SAE 90 for summer straight mineral oil to filler plug opening. (This is the same as hydraulic system oil).

SERVICING PROCEDURES FOR THE MF 65 HEAVY-DUTY BELT PULLEY

The heavy-duty belt pulley is a self-contained unit, however, a special pulley adaptor kit consisting of a PTO extension and a belt pulley adaptor housing is necessary for attaching the assembly to the MF 65 tractor.

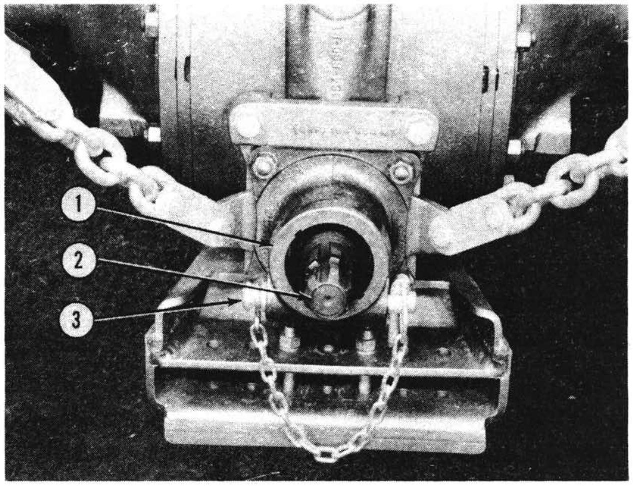

Fig. 4 – Preparing Tractor for Installation

1. Adapter Housing
2. PTO Extension
3. Retaining Pin

SELECTING DRIVEN PULLEY DIAMETER

To determine the diameter of the driven pulley, necessary to obtain a given RPM, refer to the right hand side of the table, Fig. 1. Note that there is a choice of pulley sizes for any one pulley rate; however, each size is based on a specific engine RPM. In most cases the engine RPM required to operate the belt equipment will be determined to a large degree by the horsepower or load requirements of the equipment. In general, the greater the load involved, the more horsepower will be required, and consequently a higher engine RPM will be necessary.

CAUTION: To avoid static electricity when using the belt and pulley, ground the tractor by wrapping a chain around the front axle and drop one end on the ground.

REMOVING THE BELT PULLEY

Remove:

1. Retaining pin, No. 3, Fig. 4.
2. Belt pulley as a unit.
3. Adaptor housing, No. 1, Fig. 4, by removing four nuts securing it to PTO housing.

DISASSEMBLING THE BELT PULLEY

Refer to Fig. 5, drain oil, and remove:

1. Input bearing housing assembly, No. 1, from pulley drive housing assembly, No. 6.
2. Gasket, seal, No. 2, and needle bearing, No. 3, from input bearing housing.
3. Expansion plug, No. 14, nut, No. 15, and washer, No. 16.
4. Pulley drive gear, No. 4 (drive it out of housing).

5. Pulley, No. 5, from hub, No. 10.
6. Nut, No. 13, and washer, No. 12, from pulley drive pinion, No. 21.
7. Hub and seal, No. 11, from pinion.
8. Seal, No. 9, and outer bearing cone, No. 8, from housing.
9. Pinion from housing.
10. Inner bearing cone, No. 20, from housing.
11. Snap ring, No. 17, and ball bearing, No. 18, from housing.
12. Inner and outer bearing cups, Nos. 7 and 19, from housing.

INSPECTING THE BELT PULLEY

Clean and inspect all parts thoroughly and examine for wear and damage.

ASSEMBLING AND INSTALLING THE BELT PULLEY

To assemble and install the belt pulley, reverse the procedures for disassembly and removal respectively.

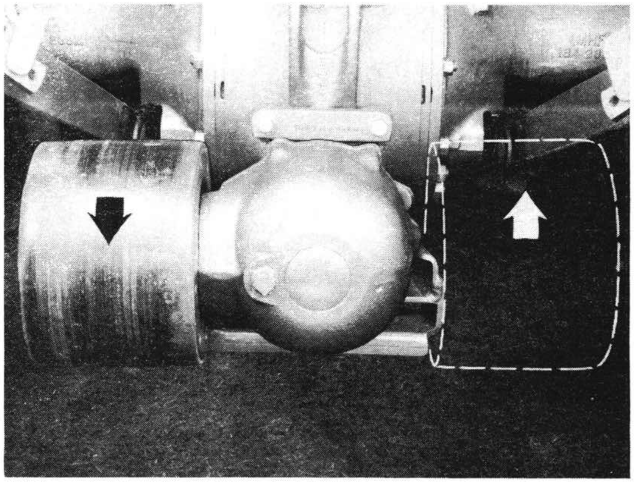

Fig. 6 – Installing the Belt Pulley

Fill with SAE 80 for winter (SAE 90 for summer) straight mineral (hydraulic system oil) to filler plug opening.

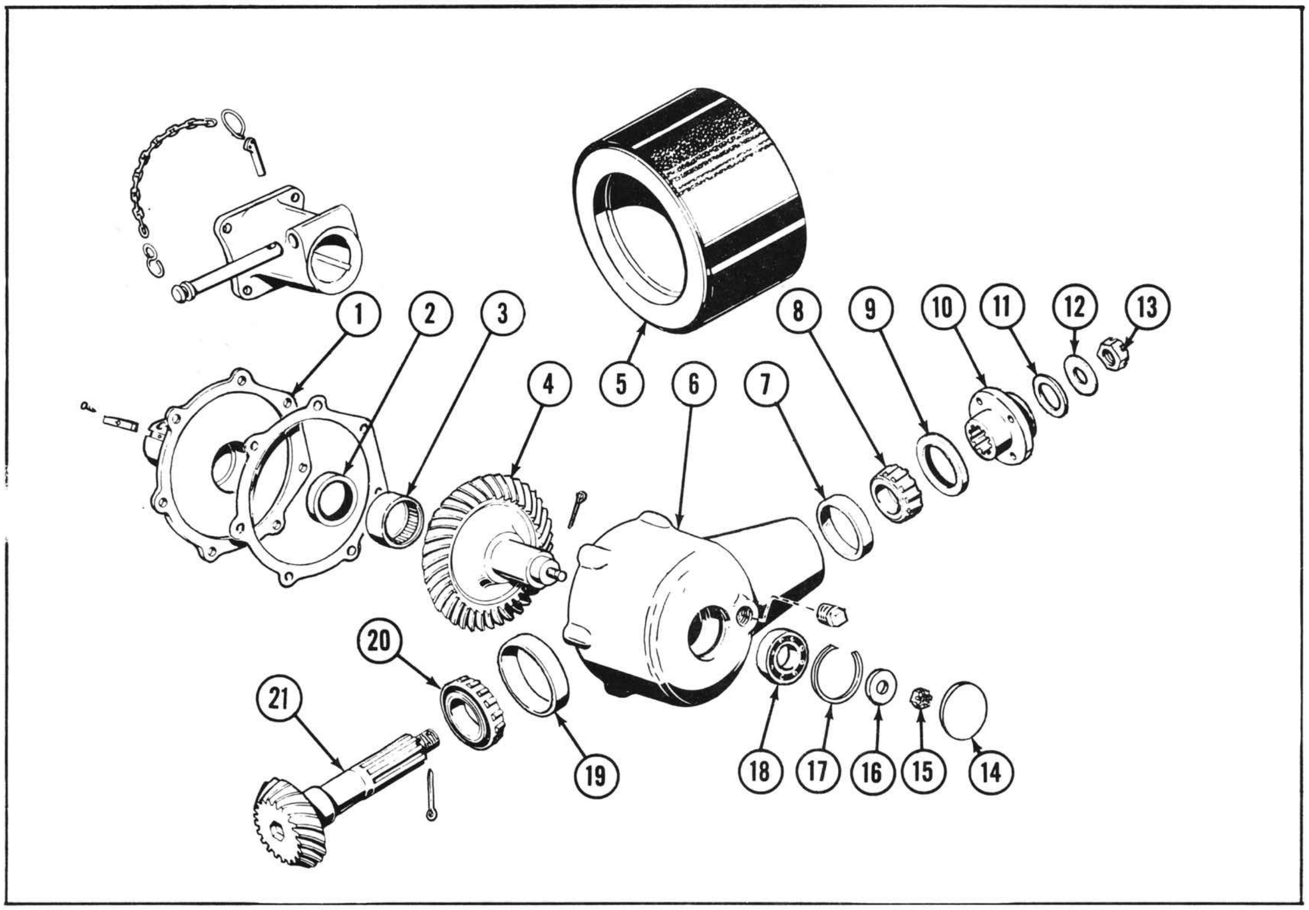

Fig. 5 – Belt Pulley Nomenclature

1. Input Bearing Housing
2. Oil Seal
3. Needle Bearing
4. Drive Gear Assembly
5. Pulley Assembly
6. Drive Assembly Housing
7. Bearing Cup
8. Bearing Cone
9. Oil Seal
10. Drive Hub
11. Oil Seal
12. Washer
13. Castellated Nut
14. Expansion Plug
15. Castellated Nut
16. Washer
17. Snap Ring
18. Ball Bearing
19. Bearing Cup
20. Bearing Cone
21. Drive Pinion

PART 1

INTERNAL HYDRAULIC SYSTEM

MF & TO 35, 50, AND 65 TRACTOR

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There is no "sure-fire" shortcut by which the internal adjustment of the hydraulic system can be checked externally. It is strongly recommended that whenever any malfunction of the hydraulic system of the Massey-Ferguson Tractor is encountered, the cause of which is not readily apparent, the hydraulic adjustments should be checked in a careful, systematic manner, following the procedure outlined in this manual.

NOTE: Always check implements for proper adjustment and damage. Damaged or bent plow beams, cultivator frames, etc, will have an adverse effect on the operation of the system.

It is not necessary to split the tractor when working on the hydraulic system. It must be kept in mind that excessive "tear-down" is done throughout this manual for reasons of clarity and ease of photography.

HYDRAULIC SYSTEM CHANGES

Some changes were made in the hydraulic system of the early "35" tractors.

The main change was the increase of pressure of the hydraulic system from 2,000 p.s.i. to 2,500 p.s.i. This change required that the lift cover and lift linkage also be strengthened.

CAUTION: Only the strengthened parts may be used when servicing the 2,500 p.s.i. hydraulic system.

The pressure relief valves are easily identified; however, extreme care must be exerted that the relief valve of the correct pressure is used.

Notice in Fig. 1 the identifying shoulder present on the 2,500 p.s.i. pressure relief valve.

Along with this change, the bore size of the pump piston was changed. This increased the efficiency of the pump by approximately 30% and makes the pump capable of delivering slightly over 4 gallons per minute at approximately 2,000 r.p.m.

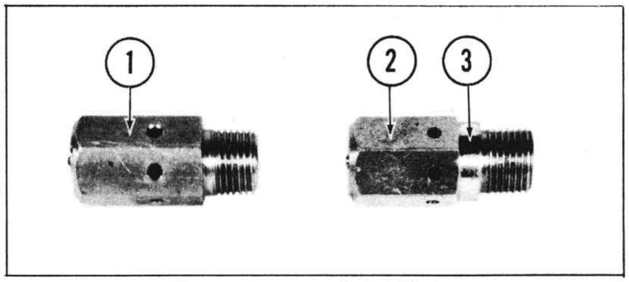

Fig. 1 - Pressure Relief Valves
1. 2000 p.s.i. Valve
2. 2500 p.s.i. Valve
3. Identify Shoulder

Tractors affected by these changes are as follows:

All Ferguson "35" tractors up to, and including, tractor serial No. 169395 were manufactured with the 2,000 p.s.i. hydraulic system.

Below are listed the tractor serial numbers of all "35" tractors manufactured with the new 2,500 p.s.i. hydraulic system.

Beginning at tractor serial No. 169396, to and including 169407.

Beginning at tractor serial No. 169419, to and including 169428.

Beginning at tractor serial No. 169467, to and including 169554.

Beginning at tractor serial No. 169567 and all "35" tractors above this will be manufactured with the 2500 p.s.i. hydraulic system. All MH 50 (Utility) since serial No. 500630 and MH 50 (Row Crop) since serial No. 500001 and all MF 50 tractors have the 2500 p.s.i. system. All MF 65 tractors have the 2,500 p.s.i. system.

Below are listed the tractor serial numbers of all "35" tractors which were manufactured with the 2,000 p.s.i. hydraulic system.

All "35" tractors up to and including tractor Serial No. 169395.

Beginning at tractor serial No. 169408 to, and including 169418.

Beginning at tractor Serial No. 169429 to, and including 169466.

Beginning at tractor serial No. 169555 to, and including 169566.

Tractor serial No. 169566 is the last "35" tractor which was produced using the 2,000 p.s.i. hydraulic system.

NOTE: The tractor serial number is the only positive, external method of identifying what is built into the tractor. Always refer to your Service Bulletin file when in doubt.

HYDRAULIC SYSTEM TROUBLE SHOOTING

PROBLEM

1. Implement will not raise.

POSSIBLE CAUSE	CORRECTION
(a) Lift cover installed so that the ends of the vertical levers are behind the roller on the valve lever.	Install lift cover correctly. See Page 17.
(b) Sticking control valve	Remove inspection cover and check valve. If valve does not operate smoothly, remove pump, determine cause and correct.
(c) Leak in system	Remove inspection cover and check system while operating. Check for leaks at the ram cylinder, standpipe, control valve, and pump side chambers. Replace seals when necessary to correct.
(d) Broken, bent or damaged control linkage.	Remove inspection cover and determine if linkage is putting control valve to intake when operational lever is raised. If not, remove lift cover and determine cause.
(e) Faulty relief valve	Check valve while operating system. Replace valve if leaking.
(f) Broken or damaged internal pump parts.	Will probably be indicated by a noisy pump.

(g) Frozen ram cylinder	Remove inspection cover and check to see if relief valve is blowing.
(h) Lift arms binding	Raise lower links by hand, they should fall of their own weight.
(i) Implement weight too great for the system	Do not lift more than the system can handle without operating the relief valve.

PROBLEM

2. Implement lifts but will not lower

POSSIBLE CAUSE	CORRECTION
(a) Sticking control valve	Remove inspection cover and check valve. If valve does not operate smoothly, remove pump, determine cause and correct.
(b) Damaged control valve spring	Remove inspection cover, check valve to determine if spring will put valve to discharge. If not, remove pump, determine cause and correct.
(c) Lift arms binding	Adjust cap screws so that lower links will fall of their own weight.

PROBLEM

3. Jerky or uneven lift when the operational lever is raised.

POSSIBLE CAUSE	CORRECTION
(a) One or more inoperative side chamber valves.	Remove pump and disassemble check valve seats and check for dirt or foreign material.

PROBLEM

4. Relief valve blows when operational lever is raised to the transport position.

POSSIBLE CAUSE	CORRECTION
(a) Quadrant stop not properly positioned.	Check and adjust stop as outlined on Page 10.
(b) Check chains twisted	Correct
(c) Check chains installed in the lower holes of the anchor brackets.	Correct
(d) Lower links reversed	Correct
(e) Weight of implement too great	Do not attempt to lift excessive weight.

PROBLEM

5. Implement will not lower or will raise when the operational lever is moved to the lower stop.

POSSIBLE CAUSE	CORRECTION
(a) Stop incorrectly located	Locate bottom stop as outlined on Page 10.
(b) Valve lever adjusting nut too tight.	Adjust valve lever, then check operational lever bottom stop.
(c) The self-locking adjusting nut on the horizontal spring guide for the position control linkage too loose.	Adjust the vertical levers as outlined on Page 9.

PROBLEM

6. Unable to obtain slow drop when operational lever is moved into the response sector of the quadrant.

POSSIBLE CAUSE	CORRECTION
(a) Eccentric cam on vertical position control lever not properly positioned with respect to the position control cam arm.	Adjust eccentric cam as outlined on Page 10.
(b) Self-locking nut on horizontal spring guide adjusted too tight after adjusting eccentric cam.	Adjust horizontal spring self-locking nut first, then adjust eccentric cam.

PROBLEM

7. Erratic action or poor control when operating in draft control with light pressure or tension on the top link.

POSSIBLE CAUSE	CORRECTION
(a) End play in master control spring.	Check and adjust. See Page 9.
(b) Self-locking nut on horizontal spring guide for draft control linkage too tight.	Adjust as outlined on Page 9.
(c) Damaged control linkage.	Locate trouble and correct.

PROBLEM

8. Draft control will not allow implement to obtain sufficient depth.

POSSIBLE CAUSE	CORRECTION
(a) Self-locking nut on horizontal spring guide for draft control too loose.	Adjust as outlined on Page 9.

PROBLEM

9. When operating in position control with knurled nut set on quadrant, implement does not return to the same position when the operational lever is raised and lowered again to the stops.

POSSIBLE CAUSE	CORRECTION
(a) Rollers on position control link assembly worn or binding.	Replace assembly.

The above suggested problems and corrections are concerned primarily with adjustments and indications of maladjustments which are peculiar to the internal hydraulic system. It should be pointed out, that some problems which, at first might appear to be the result of some malfunction of the hydraulic system, can be the direct result of at least two other causes: 1) failure to operate the system as it was designed to be operated and 2) maladjusted implements or implements having severely worn or damaged parts.

INSPECTING THE HYDRAULIC SYSTEM

Before attempting to inspect any of the parts of the hydraulic system, make sure that the parts are well cleaned and that they will remain clean.

> *CAUTION: Be very careful to keep dirt and grit from entering the hydraulic system.*

Inspecting the Master Control Spring

1. Make sure that the control spring is free in its bore and does not bind.
2. Make sure that the control spring is free from rust.

Inspecting the Quadrant Levers

3. Check the friction washers for excessive wear. Replace if necessary.

Inspecting the Hydraulic Pump

Remember, whenever using a micrometer or measuring device of any type, always make your measurements in several places to be sure that all wear will be discovered.

4. Measure the diameter of the cams at several locations with a suitable micrometer as shown in Fig. 2.
5. Measure the bearing jounals of the camshaft at several locations as shown in Fig. 3. Inspect the camshaft for scoring and damage from foreign material.

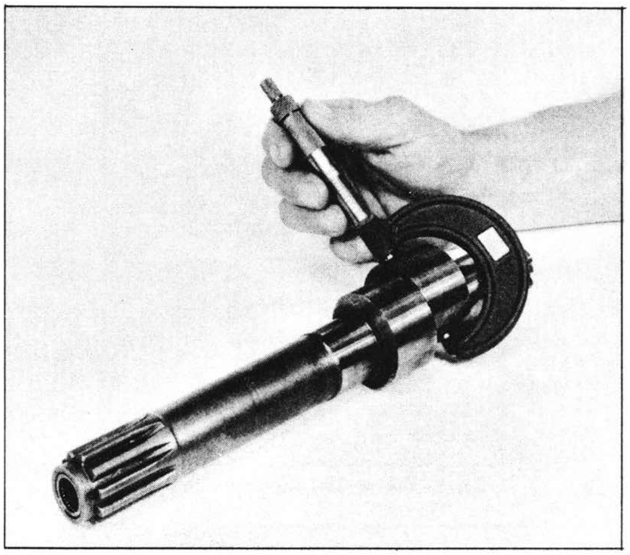

Fig. 2 - Miking the Cams

6. Measure the cam blocks, both inside and across the parallel faces as shown in Fig. 4 and Fig. 5.

7. Measure the distance between the parallel inside faces of the piston yoke as shown in Fig. 6.

8. Measure the pistons as shown in Fig. 7. Inspect the pistons for out-of-round and scoring.

9. Measure the cylinder bore in the valve chamber as shown in Fig. 8. Inspect the cylinder bore for egg shape, out-of-round, and scoring.

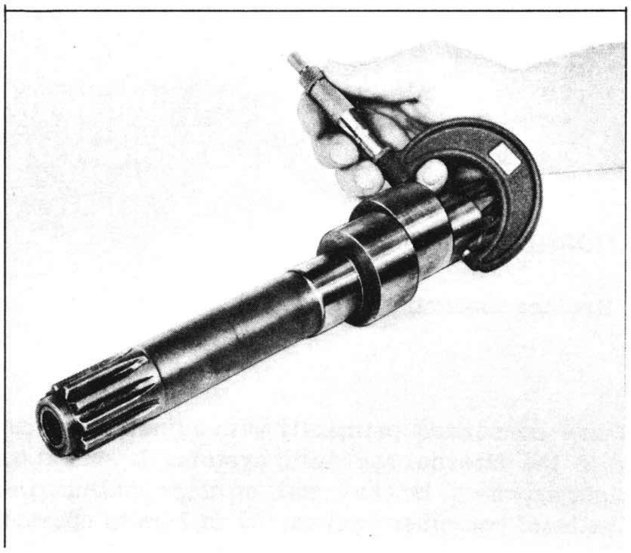

Fig. 3 - Miking Camshaft Bearing Journals

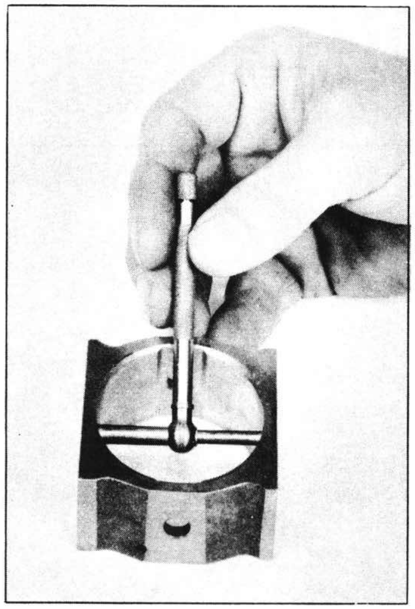

Fig. 4 - Miking Cam Block Inside Diameter

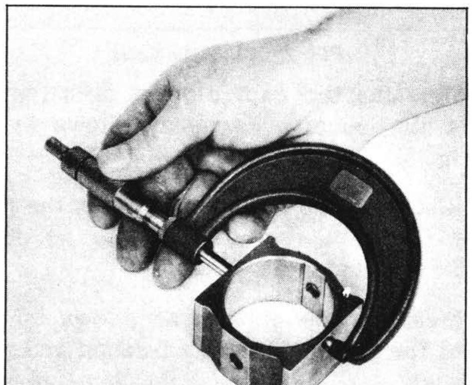

Fig. 5 - Miking Across Parallel Faces

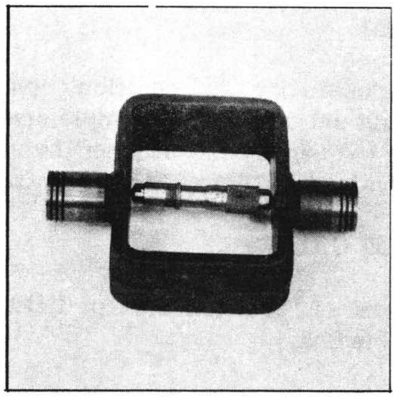

Fig. 6 - Miking Between Parallel Faces

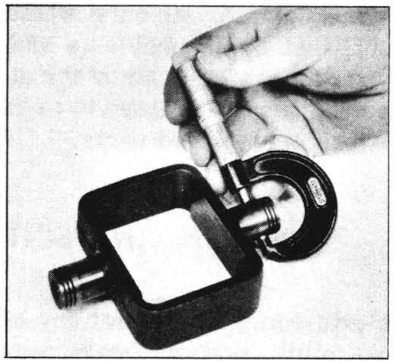

Fig. 7 - Miking Piston Diameter

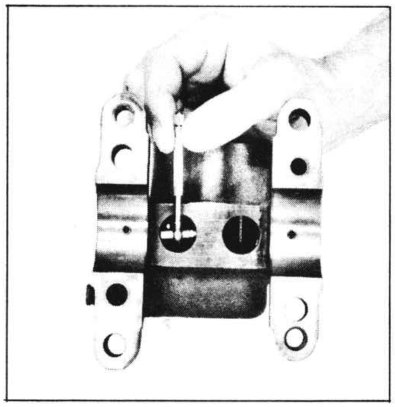

Fig. 8 - Miking Cylinder Bore

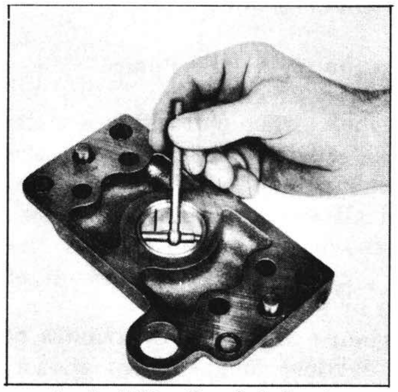

Fig. 9 - Miking Camshaft Bearing (New Type Pump)

10. Measure the inside diameter of the bronze bearings as shown in Fig. 9 and Fig. 10. Inspect the needle bearings for looseness. Inspect the bronze bearings for scoring.

11. Place the oscillator drive assembly in its proper position in the fork assembly. Slide the drive assembly back and forth several times and determine if the drive is free to move in the fork assembly without binding or sticking. If binding is present, dress the square end of the drive assembly LIGHTLY with a fine cut file or emery cloth until the binding has been removed.

> *NOTE: Any binding between these parts will cause the control valve to stick.*

12. Examine the control valve carefully for signs of scoring or grooving. Replace if necessary.

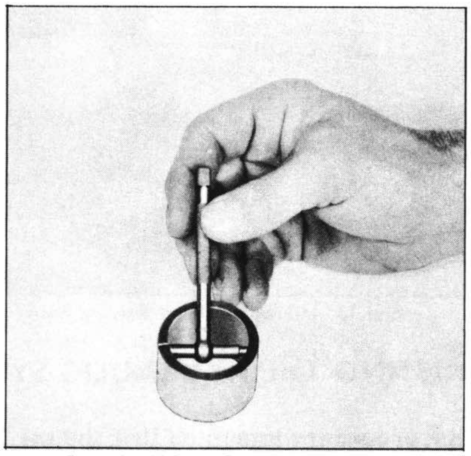

Fig. 10 - Miking Camshaft Bearing (Old Type Pump)

Inspecting the Hydraulic Lift Cover

13. Inspect the ram cylinder for signs of wear or scoring. Replace if necessary. Measure the cylinder with an inside micrometer as shown in Fig.11.

14. Inspect the piston for signs of wear and scoring. Measure the piston with a micrometer as shown in Fig. 12.

15. Remove the piston rings with an expander. Using the head of a piston, insert them in a new cylinder as shown in Fig. 13. Check the gap with a feeler gauge as shown in Fig. 14. Regardless of the condition of the old rings, it is advisable to use a new set of rings whenever either the cylinder or the piston is replaced.

16. Measure the lift shaft bearings both inside and out. See Fig. 15 and Fig. 16.

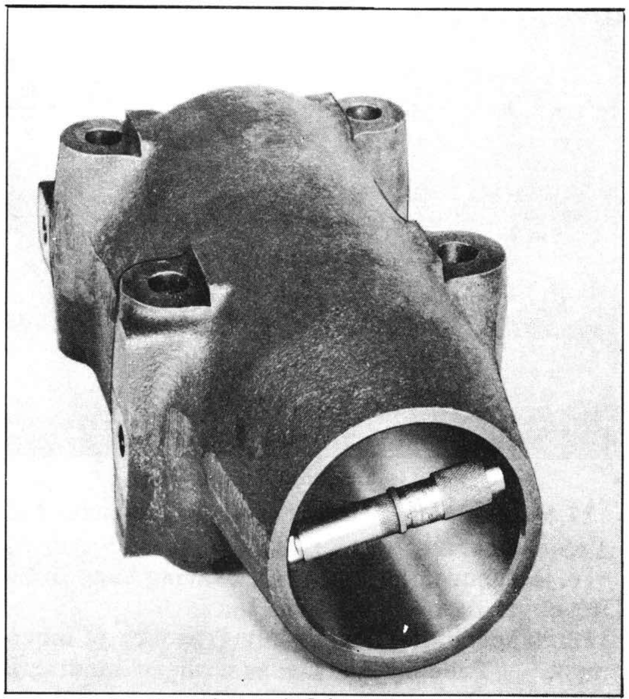

Fig. 11 - Miking Lift Cylinder Inside Diameter

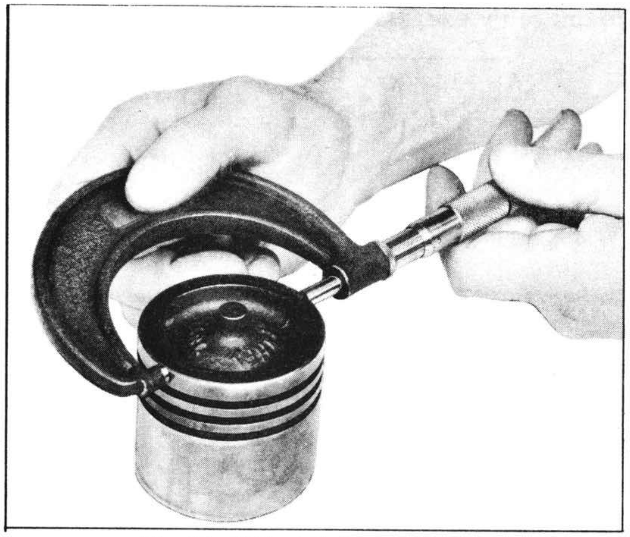

Fig. 12 - Miking Lift Piston Diameter

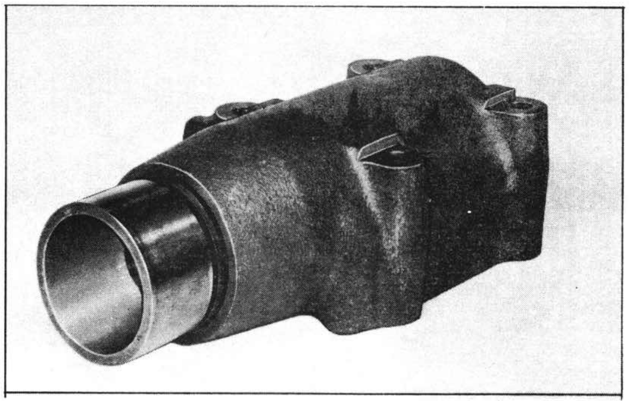

Fig. 13 - Installing Piston Ring In Cylinder

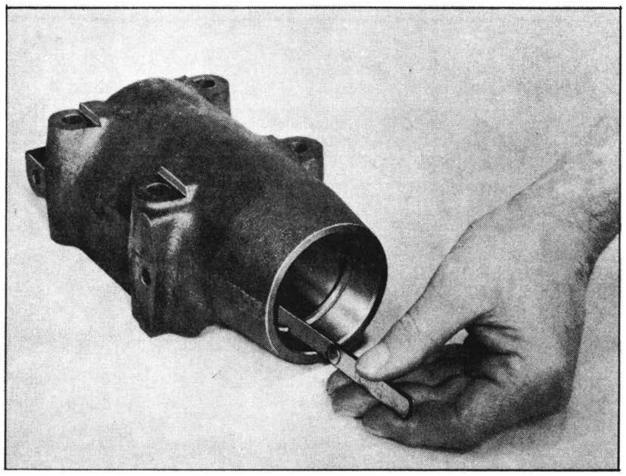

Fig. 14 - Checking Piston Ring Gap

17. Measure the lift shaft bearing journals with a micrometer. See Fig. 17.

18. Measure the lift shaft bearing bore in the lift cover as shown in Fig. 18.

19. Inspect the linkage for freedom of movement. "Free-up" any areas where binding is present.

20. Inspect the linkage rollers and cams for damage or excessive wear.

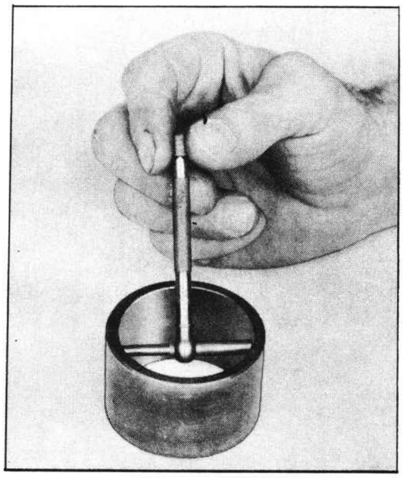

Fig. 15 - Miking Inside Lift Shaft Bearing

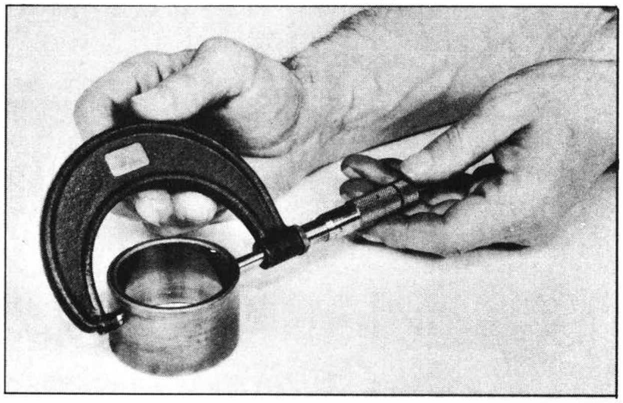

Fig. 16 - Miking Outside Lift Shaft Bearing

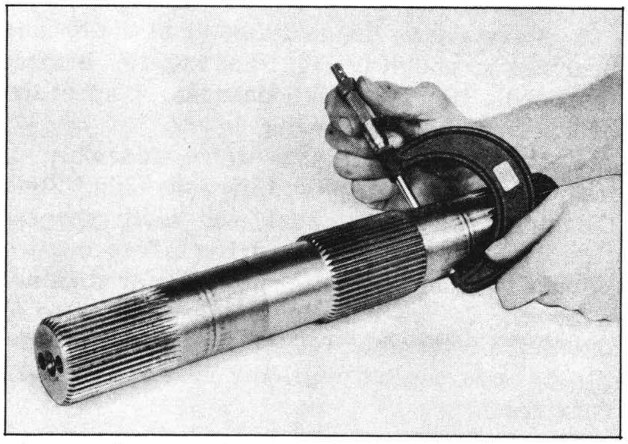

Fig. 17 - Miking Lift Shaft Bearing Journals

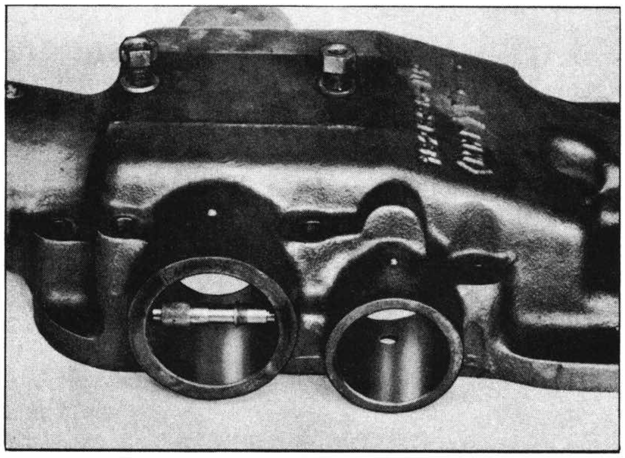

Fig. 18 - Miking Lift Shaft Bearing Bore

ADJUSTING THE HYDRAULIC SYSTEM

This procedure assumes that the oil is at the proper level and that the tractor has been operated until the temperature reaches "operating temperature".

Adjusting the Hydraulic Lift Arms

1. Adjust the cap screws shown in Fig. 19, in the ends of the lift arm shaft by:

   a. Lift the attached lower lift links to their uppermost position.

   NOTE: Do not have a drawbar attached.

   b. Tap the lift links lightly with the hand to start their movement downward.

   c. Tighten (or loosen) the cap screws until the lift links, once started, will fall by their own weight.

NOTE: If the cap screws are too tight, the lift arms will bind and cause erratic action of the system. Lock the cap screws in position with the clip shown in Fig. 19.

Adjusting the Quadrant Friction Washers

2. The quadrant friction washers should be adjusted so that the quadrant levers work smoothly and easily and will still hold their position on the quadrant.

NOTE: These friction washers should never be lubricated with any type of oil or grease. If excessive binding occurs, the quadrant and washers can be coated with dry or colloidal graphite to prevent them from binding on the quadrant.

Adjusting the Master Control Spring

3. Detach tractor from any attached implement and place lower links in their lowered position. Shut off the tractor.

4. Place the quadrant levers at their respective Sector Marks on the quadrant, that is, the hydralever (often referred to as "Position Control" lever) at the "Fast" position and draft lever between the two dots on the quadrant. See Nos. 4 and 6, Fig. 20.

5. Remove the two Allen head cap screws (No. 1, Fig. 20) which attach the hydraulic lift rocker link to the control spring housing and check the master control spring for end-play.

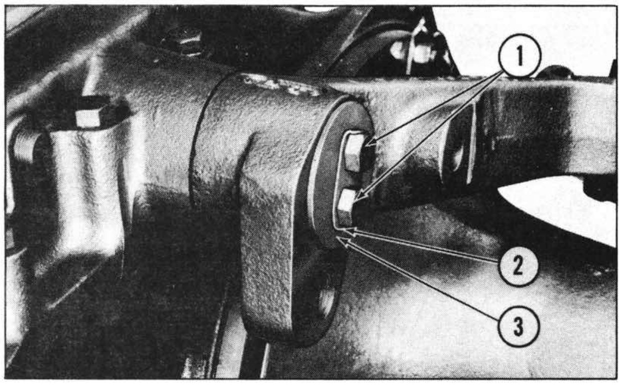

Fig. 19 - Adjusting Hydraulic Lift Arms
1. Adjusting Cap Screws
2. Locking Clip
3. Lift Arm Washer

NOTE: If end-play is present, loosen the Allen head set screw (No. 2, Fig. 20) in the right size of the control spring housing and using the OTC FT-358 Spanner wrench, turn the master control spring retainer nut (No. 5, Fig. 28) in or out as required to eliminate end-play. End-play may be caused by having the retainer nut either too loose or too tight. If the end-play cannot be removed, the master control spring must be removed and adjusted as outlined on Page 16.

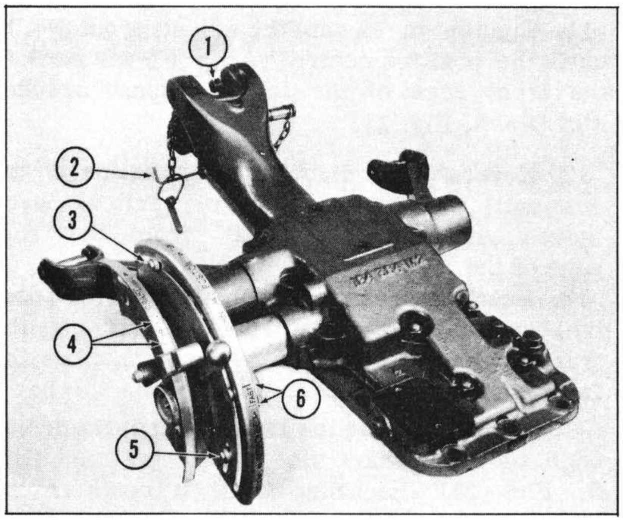

Fig. 20 - Hydraulic Lift Cover - Top View
1. Allen Head Bolt
2. Allen Head Set Screw
3. Upper Permanent Stop
4. Draft Control Sector Marks
5. Lower Permanent Stop
6. Position Control Sector Marks

Adjusting the Internal Linkage

6. Remove the right inspection side cover. Wedge the top of the control valve lever to the rear and away from the ends of the vertical levers.

7. Position the lift arms in the fully down position.

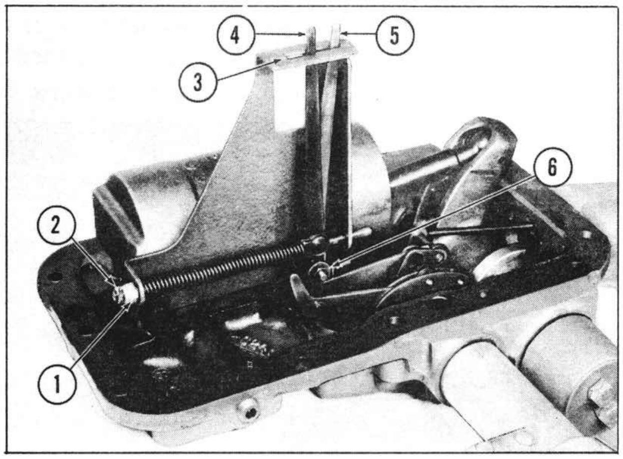

Fig. 21 - Hydraulic Lift Cover - Bottom View
1. Position Control Adjusting Nut
2. Draft Control Adjusting Nut
3. Front Edge - Lever Bracket Support Slot
4. Position Control Vertical Lever
5. Draft Control Vertical Lever
6. Roller Cam

8. Make sure that the quadrant levers are between their respective sector marks shown in Nos. 4 and 6, Fig. 20.

9. Loosen nut on roller cam (No. 6) and rotate cam counterclockwise, away from the vertical lever arms (Nos. 4 and 5, Fig. 21).

10. Maintain a slight pressure on the position control vertical lever (No. 5, Fig. 21) towards the front of the tractor.

11. Tighten (or loosen) the adjusting nut (No. 1) until the position control vertical lever strikes the front edge of the lever support bracket slot (No. 3, Fig. 21)

12. Reverse the direction of rotation of the nut until the position control vertical lever moves approximately 1/32'' from the front edge of the lever support bracket slot.

13. Exerting pressure against the position control vertical lever towards the front of the tractor, force the vertical lever against the front edge of the bracket slot.

14. While holding the lever against the front edge of the bracket slot, rotate the cam (No. 6, Fig. 21) clockwise until it contacts the vertical lever arms and tighten the nut to a torque of 5-6 ft.-lbs.

15. Placing light pressure against the draft control vertical lever (No. 4) tighten (or loosen) the adjusting nut (No. 2, Fig. 21) until the position of the draft control vertical lever is the same as that of the position control.

16. Remove the wedge and allow the control valve lever to come in contact with the vertical control lever.

Adjusting the Control Valve Lever

17. Attach a 2 or 3 bottom plow, or a weight of approximately 500 lbs. to the tractor.

18. Loosen the lower permanent stop (No. 5, Fig. 20) on the ''Position Control'' quadrant and position both of the quadrant levers at their lowest positions.

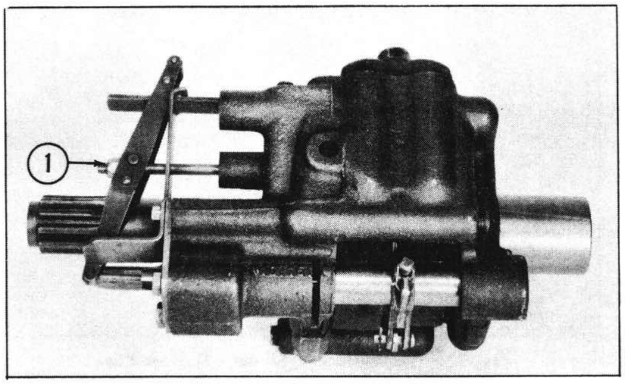

Fig. 22 – Hydraulic Pump

1. Lever Assembly Adjusting Nut

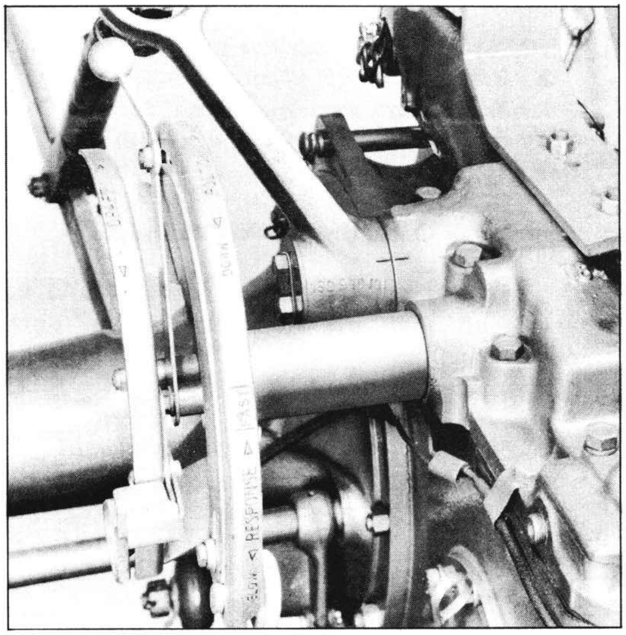

Fig. 23 - Marking Lift Cover and Lift Arm

19. Start engine and idle at 450 - 500 r.p.m.

20. Tighten control valve adjusting nut (No. 1, Fig. 22) until the implement starts to raise.

21. Raise the position control lever until the implement begins to slowly lower.

22. Position the lower permanent stop (No.5, Fig. 20) next to the position control lever and tighten.

23. Loosen the permanent upper stop (No.3, Fig. 20) on the ''Position Control'' quadrant and move the position control lever to the top until the relief valve releases.

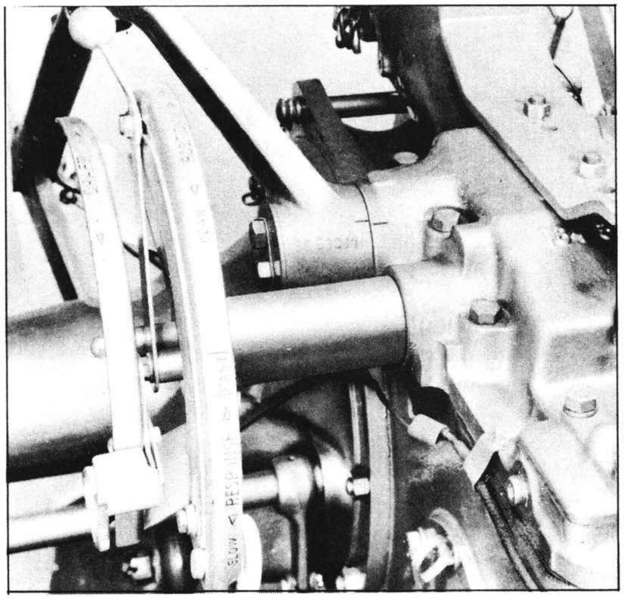

Fig. 24 - Adjusting Upper Permanent Stop

24. Using a chisel, mark the relationship between the lift arms and the hydraulic lift cover as shown in Fig. 23.

25. Lower the implement enough to separate the two marks by approximately 1/8''. See Fig. 24.

26. Position the upper stop (No. 5, Fig. 20) next to the position control lever and tighten.

27. Raise and lower implement several times so as to expell any air trapped in the system.

Checking the Response Control Settings

28. Place position control lever on its sector marks in the ''Fast'' response region.

29. Raise and lower the implement with the draft control lever.

> *NOTE: If the implement lowers rapidly, ''Fast'' response setting is correct.*

30. Place position control lever in the ''Slow'' response position.

31. Raise and lower implement several times with the draft control lever.

> *NOTE: If the implement lowers slowly, ''Slow'' response is properly set.*

SERVICING THE HYDRAULIC LIFT COVER

Removing the Hydraulic Lift Cover

1. Remove the tractor seat. See Group IV, Section C.

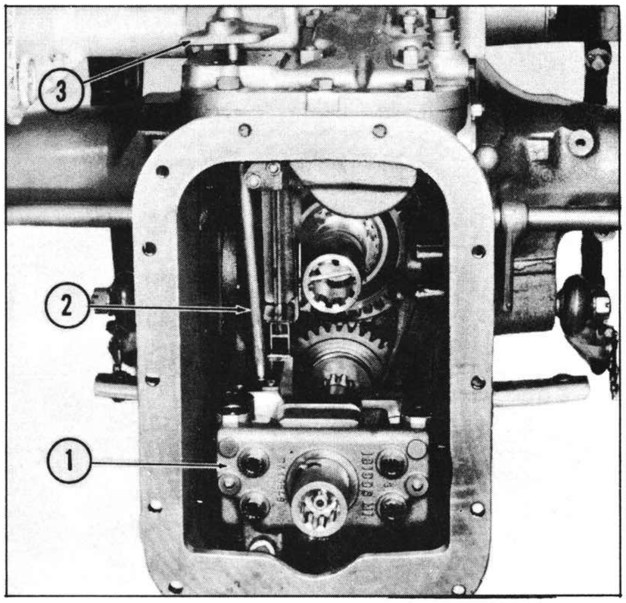

Fig. 25 - Removing Transfer Plate

1. Hydraulic Pump 2. Standpipe
3. Transfer Plate

> *NOTE: Make sure that the hydraulic lift arms are all of the way down before attempting to remove the transfer plate.*

2. Remove the transfer plate (No. 3) and standpipe (No. 2, Fig. 25).

> *CAUTION: If extreme resistance is met rotate the transfer plate while lifting. DO NOT USE A PRY TO REMOVE THE PLATE.*

3. Remove the cap screws securing the lift cover to the differential center housing.

4. Disconnect the lower lift links.

5. Remove the lift cover. See Fig. 26.

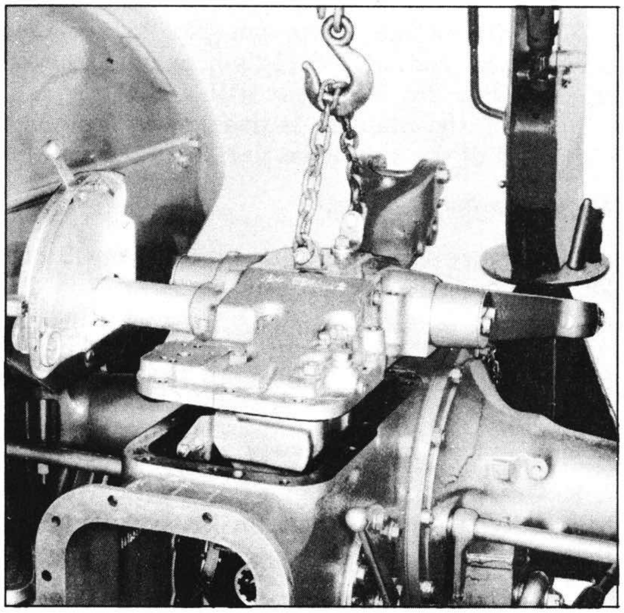

Fig. 26 - Removing Hydraulic Lift Cover

DISASSEMBLING THE LIFT COVER

Removing and Disassembling the Master Control Spring

1. Remove the special cap screws (No. 1, Fig. 20) from the lift rocker link.

2. Remove the Allen set screw (No. 2, Fig. 20) and remove the control spring retainer nut (No. 5, Fig. 28).

3. Remove the master control spring assembly shown in Fig. 27 and place it in a vise. Remove the overload stop disc from the control spring bore.

4. Slide the rubber boot (No. 4) down towards the spring and remove the rubber plug (No. 2, Fig. 28) in the end of the control spring clevis.

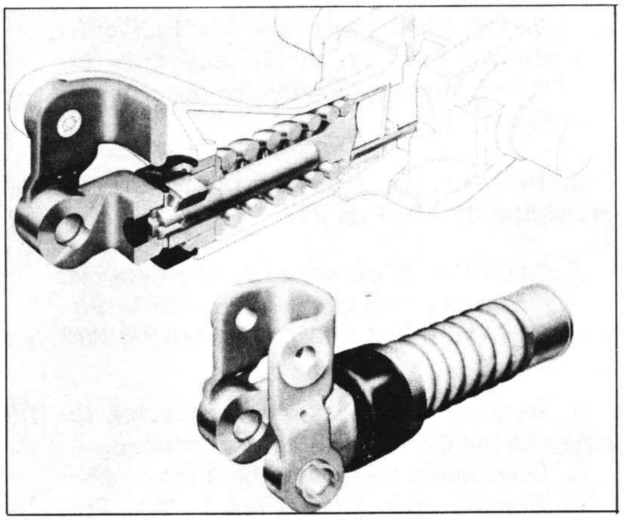
Fig. 27 - Master Control Spring Assembly

5. Drift out the clevis pin (No. 3) and turn the slotted end of the control spring plunger (No. 8, Fig. 28) clockwise with a screwdriver.

6. Once the plunger is unscrewed from the clevis all of the individual parts are accessible.

Removing the Quadrant

7. Remove the Allen Set screw (No. 1, Fig. 29) which secures the quadrant to the lift cover.

8. Remove the quadrant from the lift cover by sliding it out of the side of the hydraulic lift cover.

Removing the Control Linkage

9. Grasp the spring guide rod with a pair of locking-type pliers as shown in Fig. 30. Pull the guide rod forward, compressing the spring, until the end of the guide rod comes out of the support bracket. Allow the guide rod to go back against the support bracket as shown in Fig. 31.

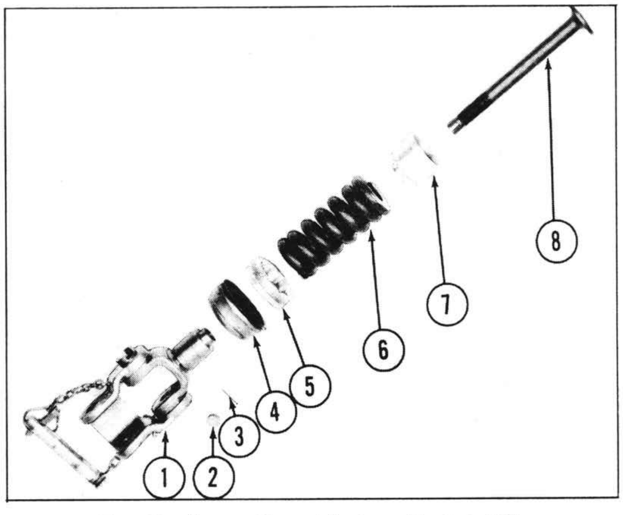

Fig. 28 - Master Control Spring - Exploded View

1. Control Spring Clevis and Rocker Link	5. Retainer Nut
2. Rubber Plug	6. Control Spring
3. Clevis Pin	7. Spring Seat
4. Rubber Boot	8. Plunger

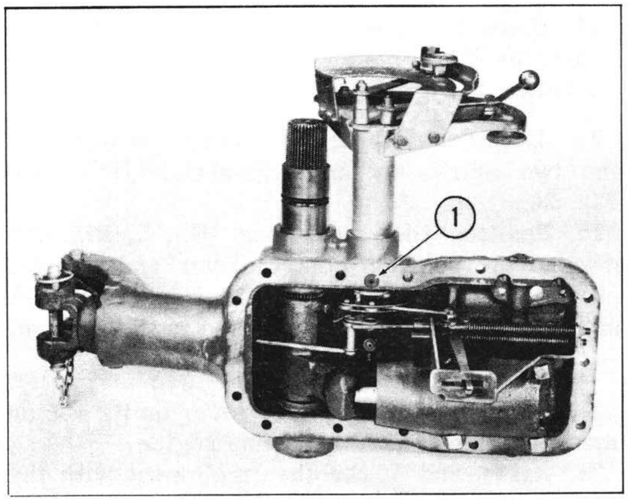

Fig. 29 - Hydraulic Lift Cover

1. Quadrant Set Screw

10. Carefully remove the self-locking adjusting nut.

11. Grasp the guide rod firmly as shown in Fig. 30, and remove it from the lift cover.

> *NOTE: Use care when removing the guide rod from the lift cover so that the compressed spring is not released too rapidly.*

12. Remove the position control vertical lever from the lift cover.

13. Follow Steps 6 through 9 to remove the draft control vertical lever.

> *NOTE: Remove the draft control vertical lever after Step 6 and before Step 7.*

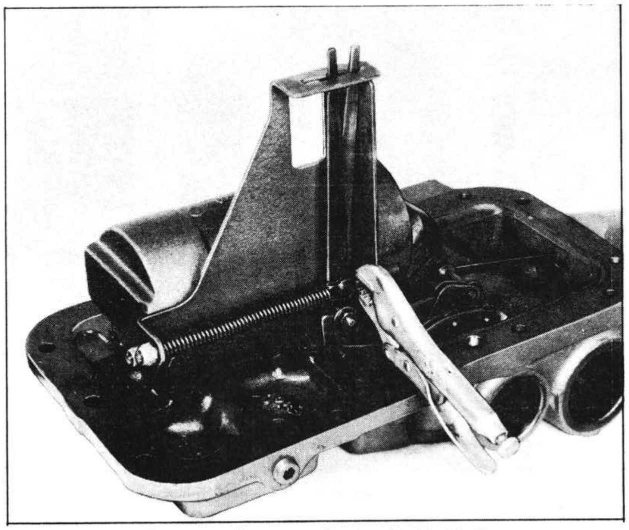
Fig. 30 - Grasping Spring Guide Rod

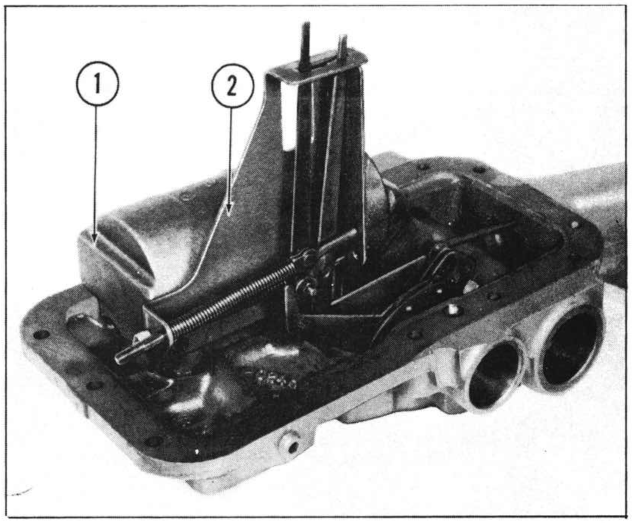

Fig. 31 - Removing Spring Guide Rod
1. Hydraulic Lift Cylinder 2. Lever Support Bracket

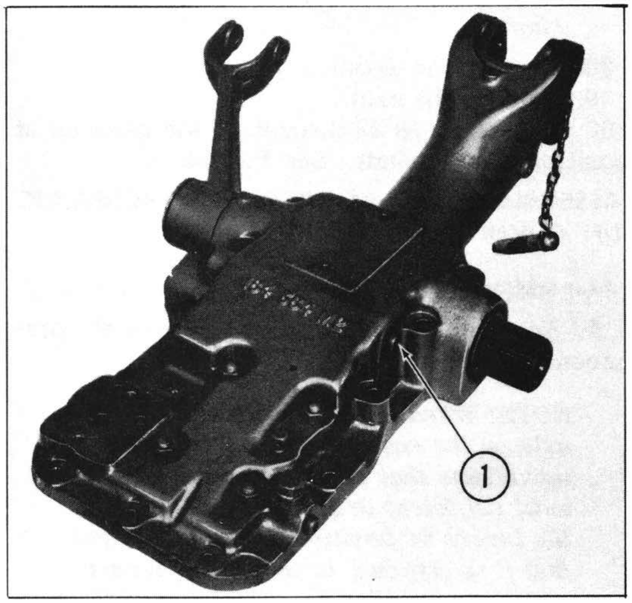

Fig. 32 - Removing Lift Shaft
1. Allen Head Pipe Plug

14. Remove the Allen pipe plug (No. 1, Fig. 32) from the left side of the lift cover.
15. Remove the Allen head set screw (No. 2, Fig. 33) from the lift cover.
16. Remove the link shaft (No. 1, Fig. 33) sliding it out of the side of the lift cover as shown in Fig. 34.
17. Remove the draft control link assembly (No. 3) and the position control link assembly (No. 4, Fig. 33) from the lift cover.

Removing the Lift Cylinder

18. Remove the bolts attaching the lever support bracket (No. 2, Fig. 31) to the lift cylinder (No. 1, Fig. 31).

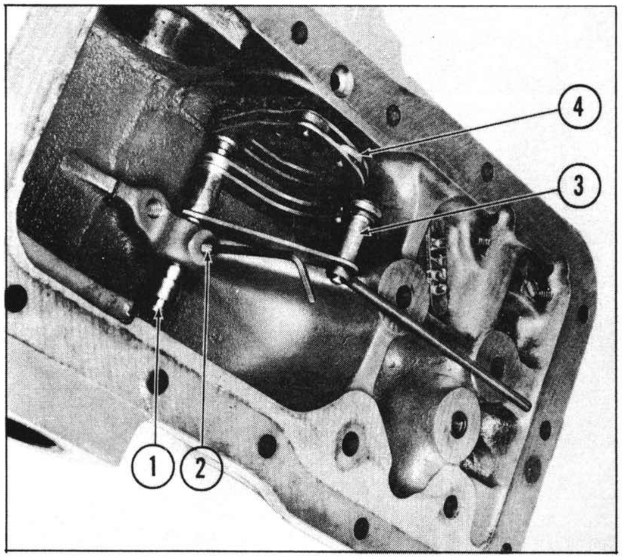

Fig. 33 - Removing Link Shaft Assembly
1. Link Shaft 3. Draft Control Link Assembly
2. Allen Head Set Screw 4. Position Control Link Assembly

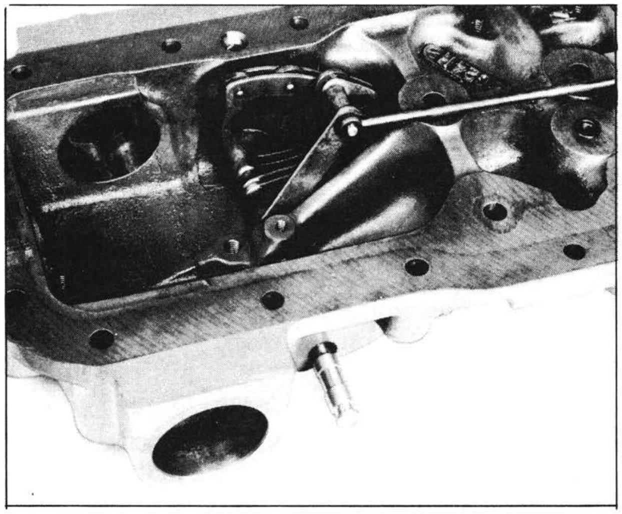

Fig. 34 - Removing Link Shaft

19. Drift out the roll pin (No. 2) and remove the piston connecting rod (No. 3, Fig. 35).
20. Remove the bolts attaching the lift cylinder to the cover and remove the lift cylinder.

> *NOTE: The lift cylinder may be removed and replaced without disturbing any of the control linkage. Remove the bolts attaching the lever support bracket to the lift cylinder and then the bolts attaching the lift cylinder to the lift cover.*

21. Remove the piston from the lift cylinder.

Removing Hydraulic Lift Arms

22. Unlock the clips from the bolt heads and remove the bolts and lift arm washer (No. 3, Fig. 19).

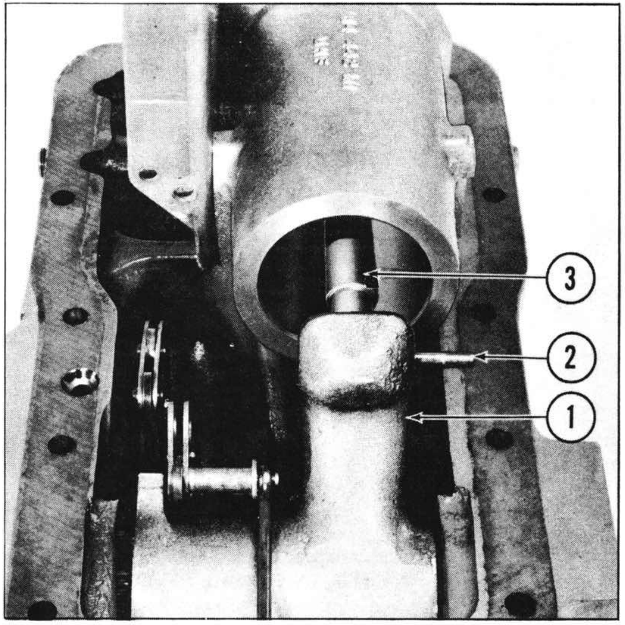

Fig. 35 - Removing Connecting Rod
1. Lift Ram Arm 2. Roll Pin 3. Lift Piston Connecting Rod

23. Slide the lift arm (No. 6, Fig. 36) off the shaft as shown in Fig. 32.
24. Grasp the lift arm on the opposite side of the lift cover and pull the lift arm and shaft from the cover as shown in Fig. 37.

> *NOTE: Resistance met is offered by "O" rings between the lift shaft bearings. Once removed the lift arm may be removed from the shaft.*

Disassembling the Quadrant

25. Remove bolts attaching the draft control quadrant to the position control quadrant.
26. Remove the nut on the end of the draft control shaft.
27. Remove the draft control quadrant from the shaft.

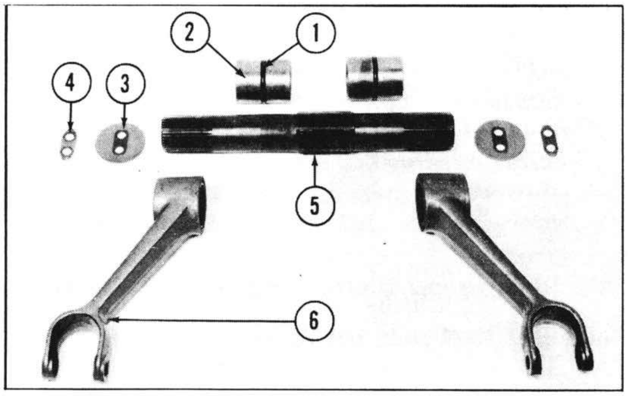

Fig. 36 - Lift Shaft Assembly
1. "O" Rings 3. Lift Arm Washers 5. Lift Shaft
2. Lift Shaft Bearings 4. Locking Clips 6. Lift Arms

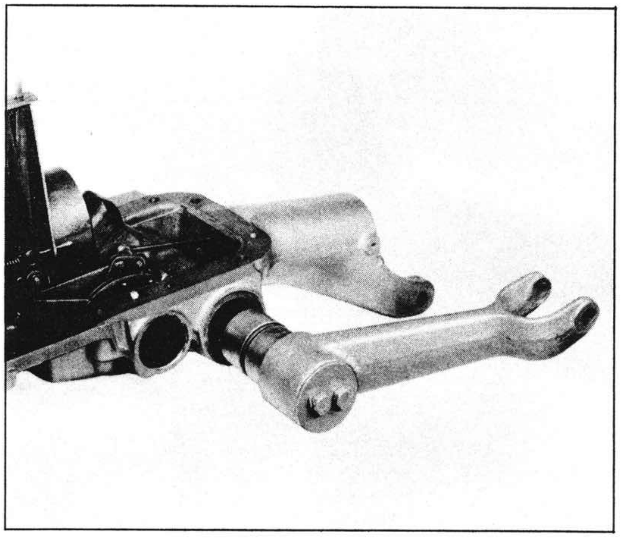

Fig. 37 – Removing Lift Shaft

> *NOTE: The quadrant is keyed to the shaft.*

28. Remove the woodruff key.
29. Remove the shaft.
30. Repeat Steps 22 through 25 for removal of position control shaft. See Fig. 38.

ASSEMBLING AND ADJUSTING THE HYDRAULIC LIFT COVER

Assembling the Quadrant

1. Assembly quadrant by reversing disassembly procedure.

> *NOTE: When tightening the self-locking nuts on the end of the quadrant shafts, make sure that the nuts are tightened until sufficient drag is obtained to hold the levers in position but not so tight that it is difficult to move the levers.*

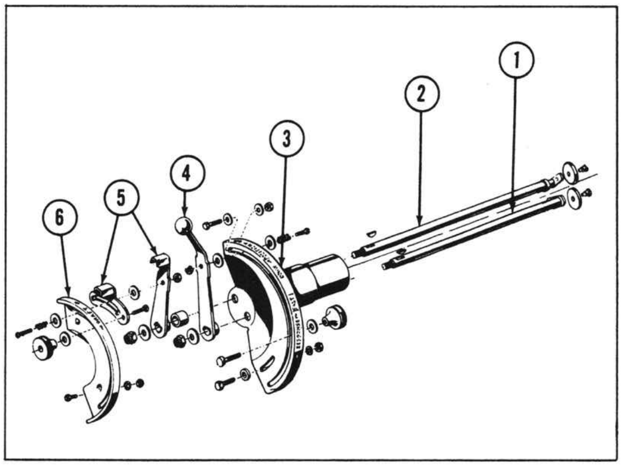

Fig. 38 - Quadrant Assembly
1. Position Control Shaft 3. Position Control Quadrant 5. Draft Control Lever
2. Draft Control Shaft 4. Position Control Lever 6. Draft Control Quadrant

Assembling and Installing the Hydraulic Lift Arms

2. Place two of the shaft bushings with an "O" ring between them on one end of the shaft.

> *NOTE: Lubricate the "O" ring with SAE 80 or 90 oil before installing.*

3. Making sure that the master spline is aligned, assemble the lift arm onto the lift shaft. Position the lift arm washer, clip and tighten bolts.

4. Place the remaining bushings, with a lubricated "O" ring between them, into the lift cover.

5. Position the hydraulic lift ram arm in the lift cover. See No. 1, Fig. 35.

6. Starting the lift arm shaft from the side of the cover which does not have the bushings and "O" ring installed, install the shaft, aligning the shaft master spline with the master spline in the lift ram arm.

7. Assemble remaining lift arm, making sure that the master spline is aligned.

8. Position the remaining lift arm washer, clip and thread in bolts tight. Loosen bolts on one side only in preparation for adjustment.

Assembling and Installing the Hydraulic Lift Cylinder

9. Assemble ring set onto piston using a piston ring expander.

> *NOTE: Install the rings so that the ring gaps are 180° from each other.*

10. Install a piston ring compressor and install the piston so that the rings enter the cylinder first. See Fig. 39.

> *NOTE: Lubricate the piston and cylinder with SAE 80 or 90 oil before installation.*

11. Position the "O" ring (No. 1, Fig. 40) in the lift cover.

12. Position the cylinder on the lift cover and secure with bolts. Tighten bolts to a torque of 65 to 70 ft.-lbs.

> *NOTE: On the earlier modeled lift covers, the two long bolts go to the rear.*

13. Install the piston connecting rod and drive in the roll pin until it is approximately centered.

> *NOTE: Lubricate the ends of the connecting rod and the mating sockets with a heavy duty moly grease before installation.*

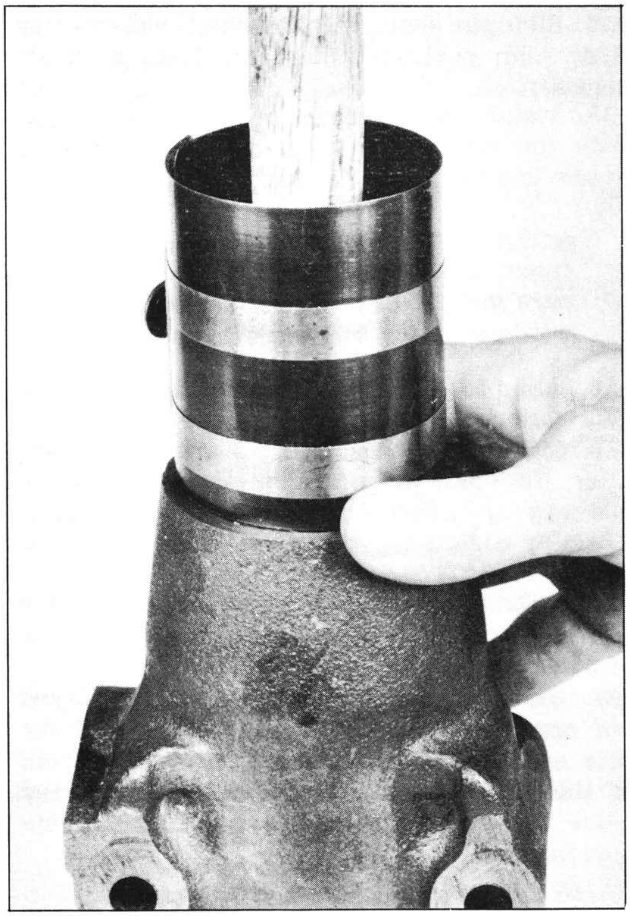

Fig. 39 - Installing the Lift Piston

14. Attach the lever support bracket to the lift cylinder. Tighten the bolts to a torque of 20 to 25 ft.-lbs.

Assembling and Installing the Control Linkage and Quadrant

15. Place the position control and draft control links in the lift cover as shown in Fig. 40.

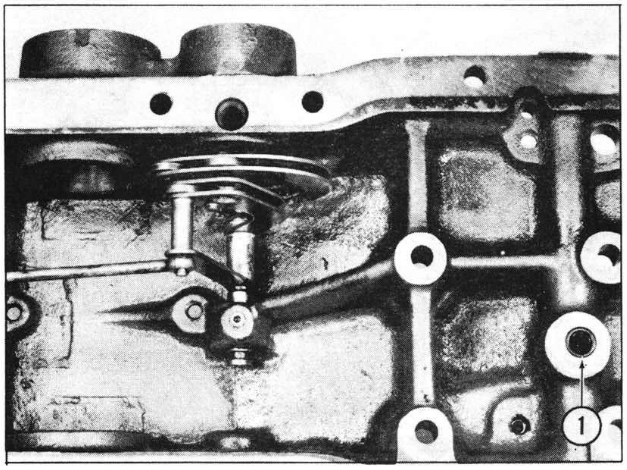

Fig. 40 - Installing the Lift Cylinder
1. "O" Ring

16. Slide the shaft, with the small end entering first, into position. Start the Allen head set screw.

17. Install the quadrant and lock in position with the Allen head set screw. Tighten the screw to a torque of 20 to 25 ft.-lbs.

> *NOTE: Whenever the hydraulic lift cover is removed, always check to make sure that this set screw securing the quadrant to the lift cover is tight.*

18. Align the control link rollers and the quadrant rollers.

19. Making sure that rollers are not moved, slide the shaft in until a minimum amount of end-play is present in the link assemblies. Lock by tightening the Allen head set screw (No. 2, Fig. 33).

20. Install the Allen head pipe plug in the left side of the lift cover. Tighten to a torque of 36-42 ft.-lbs.

21. Using locking type pliers, install guide rod and spring by placing threaded end through the hole nearest the lift cylinder and at the front of the lift cover. Compress the spring and place the end of the guide rod against the support bracket.

> *NOTE: Do not allow it to enter its guide hole at this time.*

22. Position the draft control vertical lever on the guide rod with the dowel towards the lift cylinder. See Fig. 41.

23. Align the vertical lever with the control link and then allow the rear end of the guide rod to enter the hole in the support bracket.

24. Install the position control vertical lever with the dowel towards the quadrant side of the lift cover. See Fig. 42.

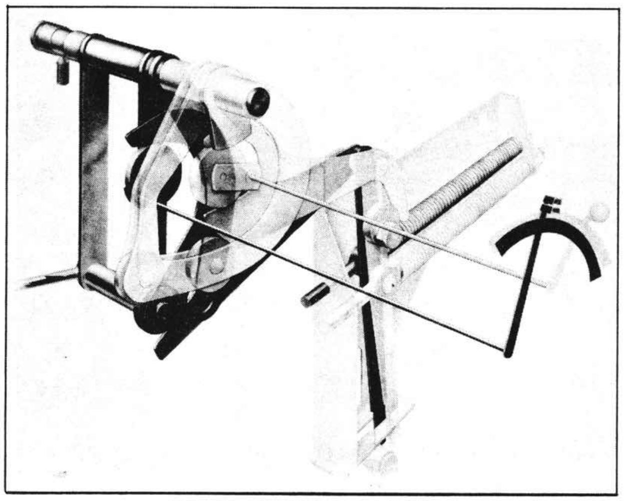

Fig. 41 - Draft Control Linkage

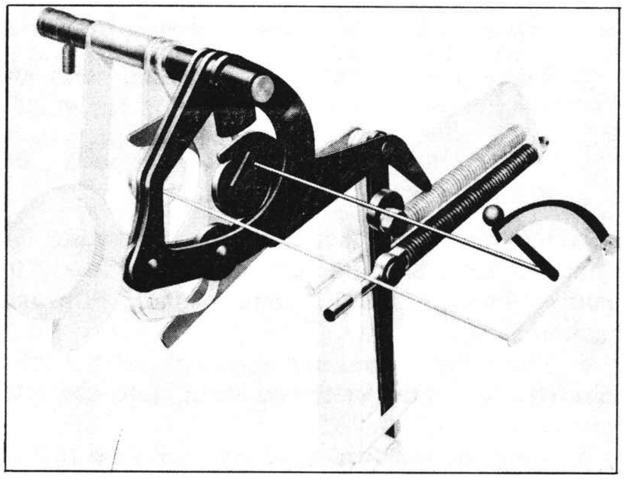

Fig. 42 - Position Control Linkage

25. Install the position control guide rod and spring. Repeat Steps 21 through 23.

Assembling, Adjusting and Installing the Master Control Spring

26. Set the control spring plunger on the bench with the threaded, slotted end up.

27. Place the control spring seat on the plunger with the "cupped" side down.

28. Place the control spring on the plunger and seat, centering it over the extended portion of the control spring seat.

29. Place the spring retainer nut on the plunger with the threaded end down.

30. Place the rubber boot on the plunger. See Fig. 28.

31. Holding the assembly in your hands, screw the plunger counterclockwise into the clevis until the plunger is snug and the spring is slightly compressed.

32. Turn the plunger until the slots align with the closest holes and install the clevis pin.

> *NOTE: Continue this until the spring is very snug but can still be rotated by hand. Do not attempt to check the adjustment without installing the clevis pin as rotation of the spring will change the adjustment of the plunger.*

33. Install the master control spring assembly in the lift cover first making sure that the overload stop disc is in its proper position.

34. Tighten the retainer nut, using OTC tool No. FT-358 until there is no end-play present.

> *NOTE: End-play may be caused by having the retainer nut too tight as well as too loose.*

35. Tighten the Allen set screw to a torque of 40-65 ft.-lbs. to hold the retainer nut in position.

36. Replace the rubber boot in the grooves provided.

37. Install the special cap screws in the lift rocker link. Tighten the cap screws to a torque of 45 to 60 ft-lbs.

Adjusting the Vertical Control Levers

38. Adjust the vertical control levers as outlined on Page 9

INSTALLING THE HYDRAULIC LIFT COVER

1. Remove the inspection cover from the right side of the differential center housing.
2. Wedge the control valve lever assembly to the rear.
3. Position a gasket and install the lift cover, less the standpipe and transfer plate, making sure that the vertical levers are in front of the upper end of the control valve lever.

> *NOTE: Make sure that the lift arms are all of the way down before attempting to install the lift cover. Torque the nuts to 45 to 50 ft.-lbs.*

4. Remove the wedge.
5. Install the standpipe and transfer plate. Tighten the cap screws to 45 to 50 ft.-lbs. torque.

> *NOTE: Make sure that the "O" rings on each end of the standpipe and the one in the transfer plate are in their proper position and are either new or serviceable.*

6. Adjust the hydraulic lift arms, see Page 8 .
7. Adjust the control valve lever assembly as outlined on Page 10 .

SERVICING THE HYDRAULIC PUMP

The hydraulic pumps used in Massey-Ferguson tractors are full-floating, constant running, positive, four cylinder, scotch yoke piston type pumps. The pump delivers oil for a system which provides implement draft control with response selection, implement position control and overload protection of attached implements.

Removing the Hydraulic Pump

1. Remove the hydraulic lift cover, see Page 11.
2. Remove the cotter pin through the rear drive shaft coupler.
3. Slide the rear drive shaft coupler over the rear drive shaft and remove the shaft and coupler from the differential center housing.

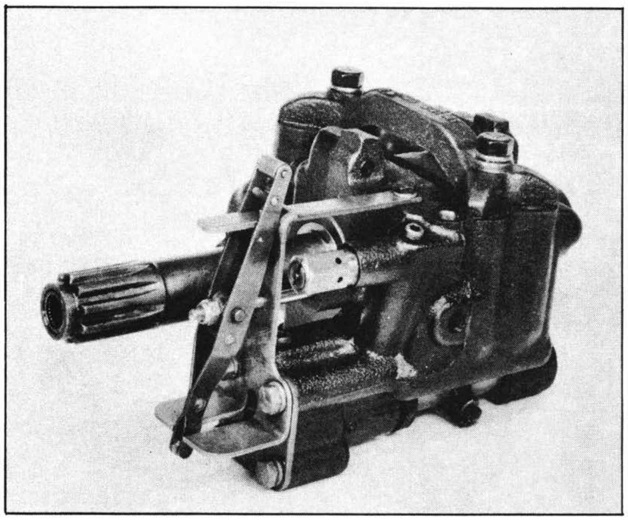

Fig. 43 - Hydraulic Pump - Old Type

4. Remove the PTO shaft as outlined in Group II, Section D.
5. Remove the dowel assembly from each side of the differential center housing.
6. Remove the pump from the top of the differential center housing.

Disassembling the Hydraulic Pump

> *NOTE: The two pumps shown in Fig. 43 and Fig. 44, presently in the field are basically the same pump. Because of their similarity, only one disassembly and assembly procedure will be given.*

1. In the older type pump, mark the relationship between the pump body and the bronze bearing. See Fig. 45.
2. Remove the lever assembly adjusting nut. (No. 1, Fig. 44).

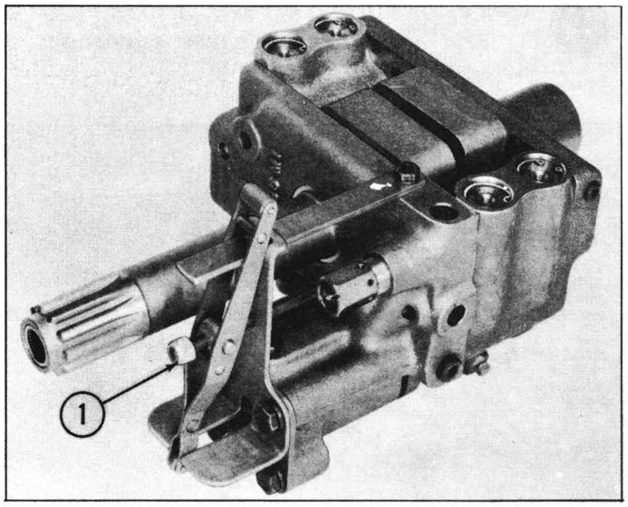

Fig. 44 - Hydraulic Pump - New Type
1. Lever Assembly Adjusting Nut

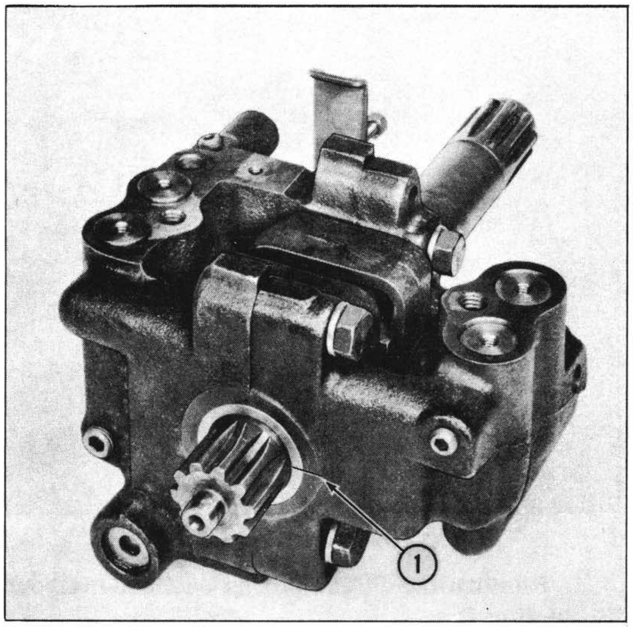

Fig. 45 - Marking Camshaft Bearing and Pump Body
1. Scribe Mark

3. Remove the lever assembly (No. 1, Fig. 49) as shown in Fig. 46.

4. Remove the attaching cap screws and remove the control valve plate (No. 3, Fig. 49) and the valve lever guide bracket (No. 2, Fig. 49) from the pump body as shown in Fig. 47.

5. Remove the control valve plate, control valve (No. 10), spacer (No. 1) valve sealing washers (Nos. 2, 5 and 9) control valve spacer (No 3) control valve "O" rings (Nos. 6 and 8) and "O" ring retainer (No. 7, Fig. 48) from the control valve chamber in the pump body. Use of the "bent wire tool" (No. 4, Fig. 48) makes this job easier.

NOTE: Never grasp the control valve by the slot edges. These edges are normally very sharp.

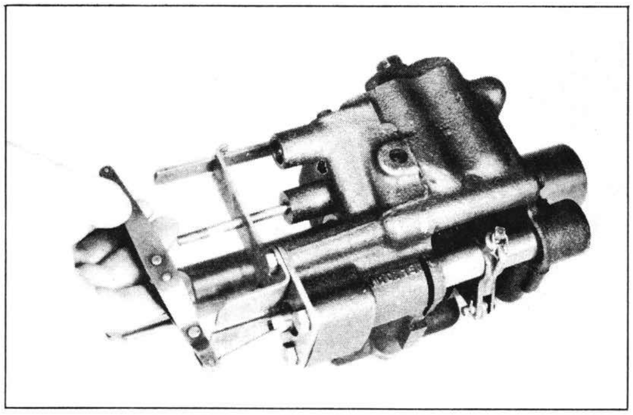

Fig. 46 - Removing the Lever Assembly

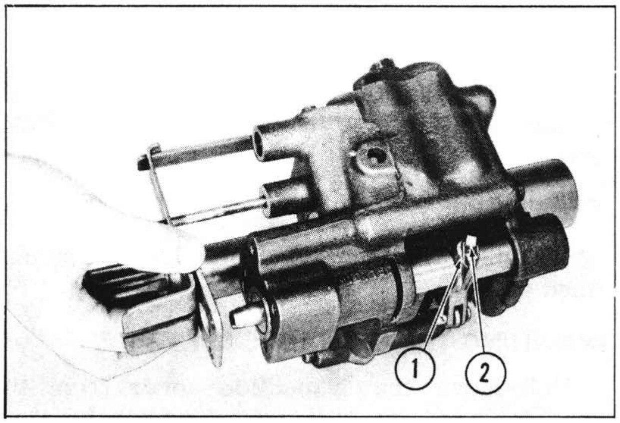

Fig. 47 - Removing the Valve Plate
1. Lock Wire 2. Set Screw

6. Remove the bolt securing the bracket lever (No. 5, Fig. 49) to the pump body and remove the bracket lever.

7. Remove the locking wire (No. 1) and set screw (No. 2, Fig. 47) from the oscillator link.

8. Remove the snap ring (No. 9) oscillator retainer washer (No. 8) and control valve oscillator assembly (No. 7, Fig. 49) from the pump body.

NOTE: The control valve oscillator assembly is removed from the front of the pump as shown in Fig. 50. In the new type pump, expand the snap ring (No. 1, Fig. 51) and slide the oscillator assembly out of the snap ring and pump.

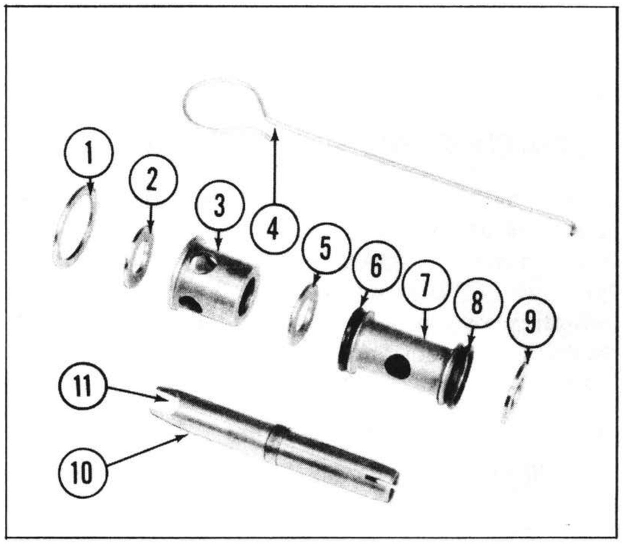

Fig. 48 - Control Valve Assembly

1. Spacer Washer
2. Sealing Washer
3. Control Valve Spacer
4. Bent Wire Tool
5. Sealing Washer
6. "O" Ring
7. "O" Ring Retainer
8. "O" Ring
9. Sealing Washer
10. Control Valve
11. Inlet End, Control Valve

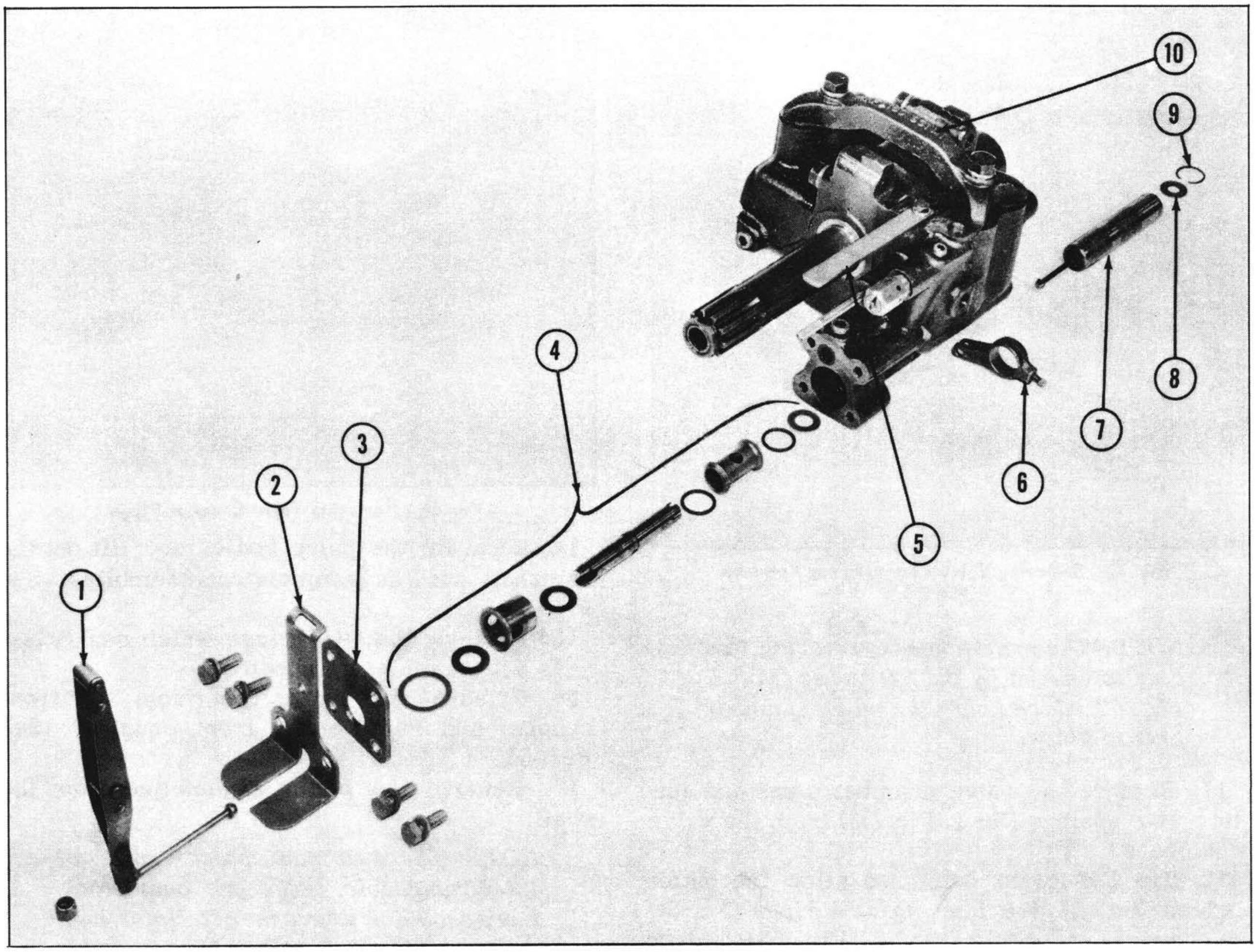

Fig. 49 - Hydraulic Pump - Exploded View

1. Control Valve Lever Assembly
2. Lever Assembly Guide Bracket
3. Control Valve Plate
4. See Fig. 48
5. Upper Valve Lever Guide
6. Oscillator Link
7. Oscillator Assembly
8. Oscillator Retainer Washer
9. Snap Ring
10. Pump Valve Retainer

9. Remove the pump valve retainer (No. 10, Fig. 49) from the pump body by removing the two cap screws attaching it to the pump body.

NOTE: In the newer type pumps, the valve chamber plug is held in place by a snap ring (No. 1, Fig. 52).

10. Using a 1/4'' national course thread, of 20 threads to the inch, stove bolt, approximately 2-1/2 to 3'' long, remove the valve chamber plug assembly (No. 1, Fig. 53) by screwing the stove bolt into the threads provided in the plug and pulling the plug out of the valve chamber. See Fig. 54.

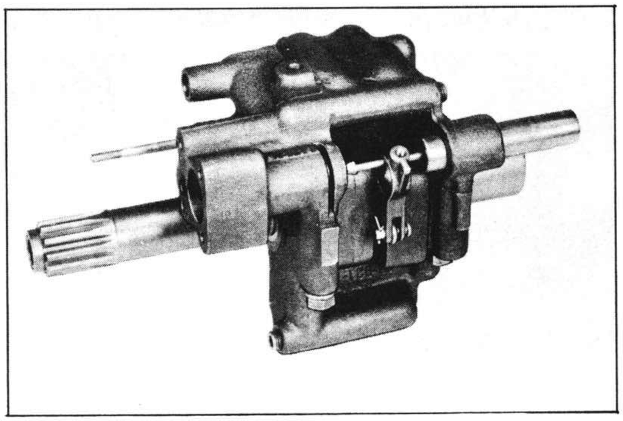

Fig. 50 - Removing Oscillator Assembly - Old Type

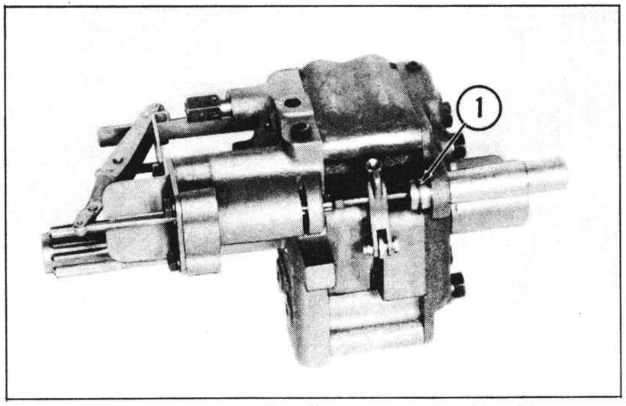

Fig. 51 - Removing Oscillator Assembly - New Type

1. Snap Ring

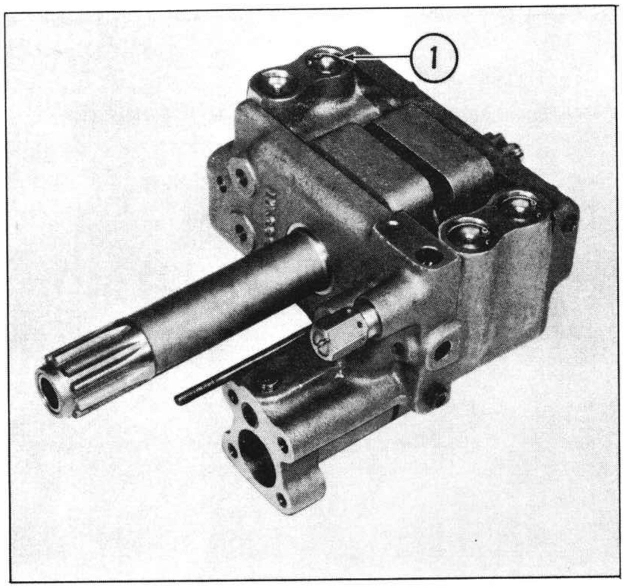

Fig. 52 - Removing Valve Chamber Plug Retainer
1. Snap Ring

NOTE: The resistance in removing this plug is caused by the "O" ring (No. 2, Fig. 53) which holds the valve chamber plug in place.

11. Remove the valve chamber plugs and outlet valve springs (No 3, Fig. 53) from the valve chambers.

12. Tip the pump over and allow the outlet valves (No. 4), the inlet valve springs (No. 5), and the inlet valves (No. 6, Fig. 53) to drop out of the valve chamber.

NOTE: NEVER USE A MAGNET WHEN WORKING ON A HYDRAULIC PUMP.

13. Remove the bolts holding the pump together.

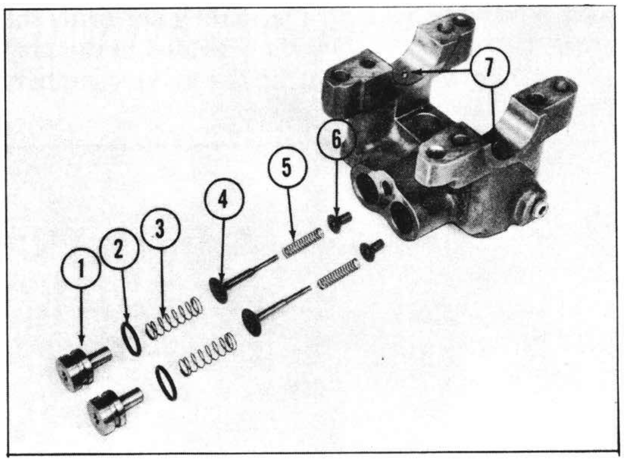

Fig. 53 - Valve Chamber Assembly

1. Valve Chamber Plug
2. "O" Ring
3. Outlet Valve Spring
4. Outlet Valve
5. Inlet Valve Spring
6. Inlet Valve
7. Dowel Pins

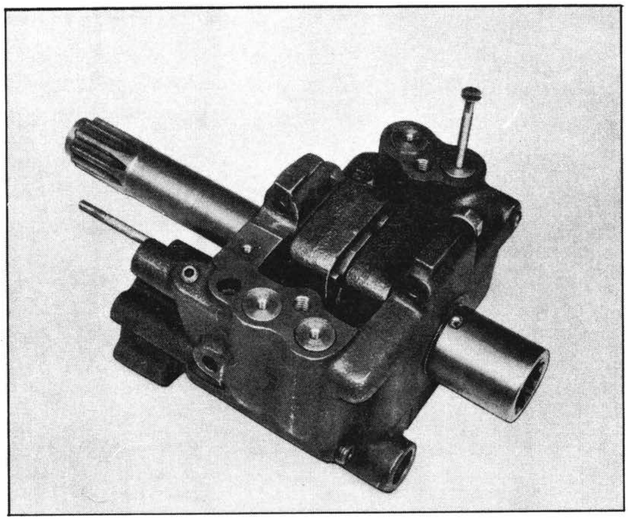

Fig. 54 - Removing Valve Chamber Plugs

14. Separate the pump bodies and lift out the camshaft and the pump piston assemblies. See Fig. 55.

15. Remove the "O" rings which seal passages between the pump bodies.

16. Remove the cotter pin from the front coupler and remove the front coupler. See Fig. 55.

17. Remove the piston assemblies from the shaft.

NOTE: The two cam blocks are not interchangeable. The one cam block has a shoulder where the oscillator cam follower rides. See Fig. 56.

Disassembling the Control Valve Oscillator

1. Remove the snap ring (No. 1, inset to Fig. 57).

NOTE: Use care whenever removing the snap ring as the spring (No. 4) will force out the spring retainer disc (No. 5, Fig. 58) from the housing.

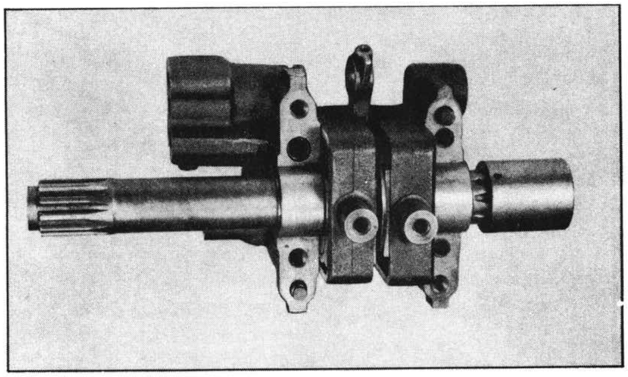

Fig. 55 - Removing Camshaft Assembly

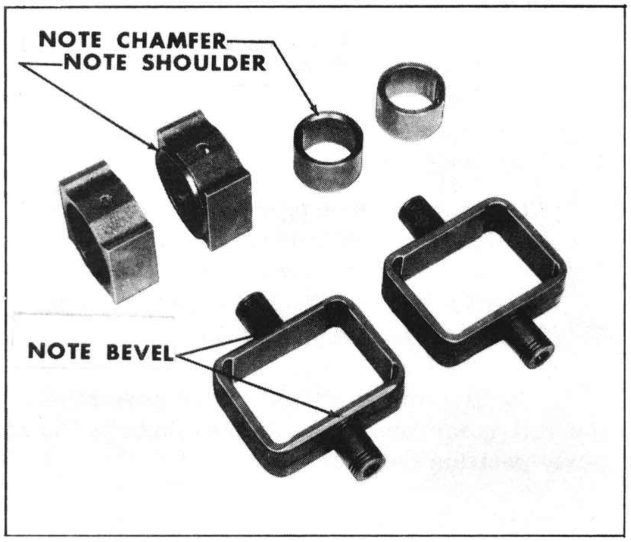

Fig. 56 - Cam Block, Camshaft Bearing and Piston Yoke Differences

2. Remove the snap ring (No. 1, Fig. 58) from the opposite end of the oscillator assembly housing.

Inspecting the Hydraulic Pump

Inspect the hydraulic pump as outlined on Page 5 . Replace the parts not meeting minimum specifications.

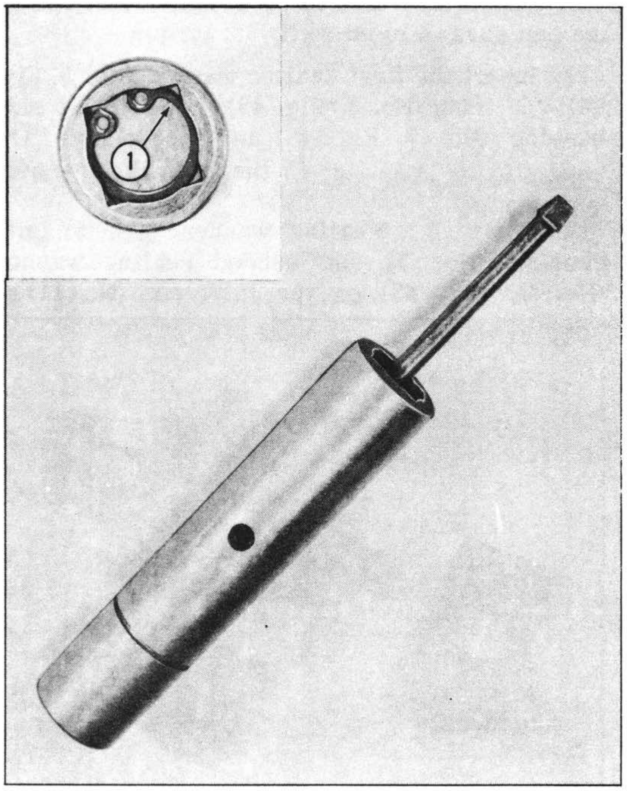

Fig. 57 - Oscillator Assembly

1. Snap Ring

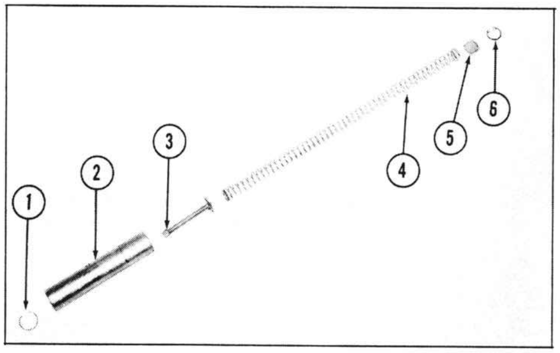

Fig. 58 - Oscillator Assembly - Exploded View

1. Snap Ring	4. Control Valve Spring
2. Oscillator Housing	5. Retainer Disc
3. Oscillator Drive Assembly	6. Snap Ring

Assembling the Control Valve Oscillator

Reassemble this unit by reversing the disassembly procedure.

NOTE: The spring may be replaced by holding the housing in a vise and using one hand to hold the spring in place, re-

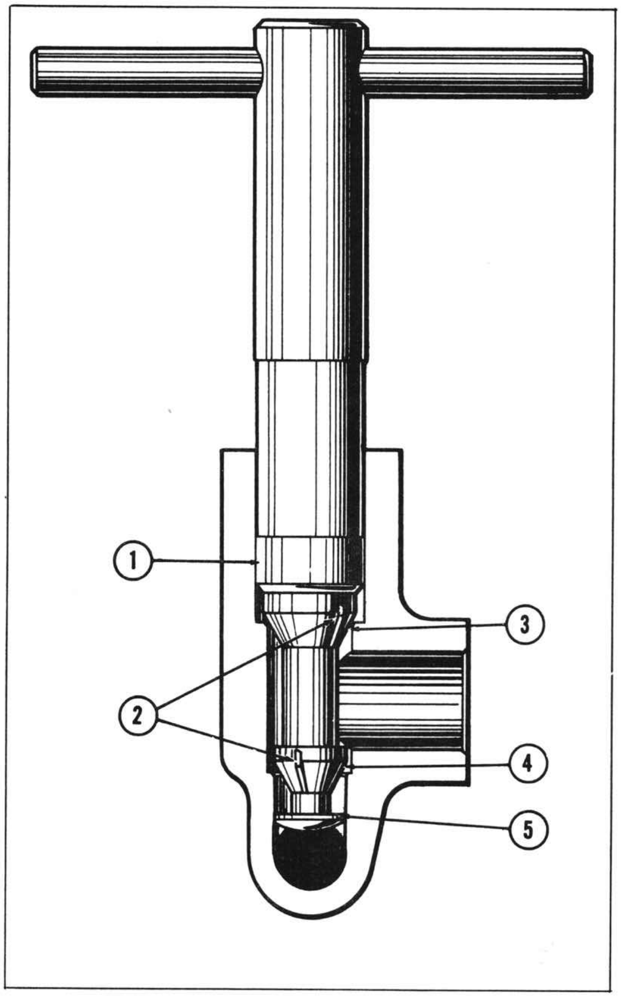

Fig. 59 - Cross-Sectioned View of Tool Installed

1. Upper Pilot Surface	4. Inlet Valve Seat
2. Cutting Edges	5. Lower Pilot Surface
3. Exhaust Valve Seat	

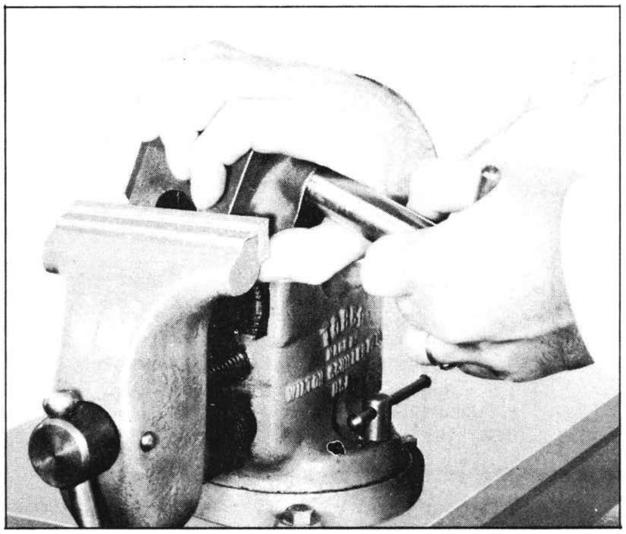

Fig. 60 - Using Reseating Tool

place the spring retainer disc and snap ring to their proper positions.

Assembling the Pump

1. Replace the side valve assemblies in their chambers and replace the plugs.

2. Place the left hand half of the pump on the bench with the piston openings up and the side chamber valve plugs toward you, your left will then be the rear of the pump.

> *NOTE: This step is for the older type pumps. Assemble the pump bodies together making sure that all of the "O" rings are replaced or serviceable.*

3. Place the cam block with the shoulder (see Fig. 56) and the oscillator cam follower on the front cam of the shaft so that the cam follower will be between the cam blocks.

> *NOTE: The long end of the camshaft is towards the control valve end of the pump. The short end of the camshaft is towards the front.*

4. Place the remaining cam block on the other cam.

5. Place the piston assemblies on the cam blocks so that the beveled edges of the assemblies are to the outside. See Fig. 56.

> *NOTE: On the new type pumps the piston yoke is not beveled. Replace yokes so that the machined surfaces are to the outside.*

6. Place the two bronze bushings on the shaft. Each bushing has one inner edge chamfered, see Fig. 56. This end of the bushing should go on the shaft first to properly position the dowel holes for the dowel pins (No. 7, Fig. 53). The two bushings are identical and may be installed in either position.

> *NOTE: In the new type pumps press in the bushings until they are flush with the outside of the pump body. Position the oil grooves (No. 1, Fig. 61) so that they are on a horizontal line as shown in Fig. 61.*

7. Position the shaft and piston assemblies in the left pump half, and align the marks to properly position the bushings.

> *NOTE: The camshaft is installed so that the long end of the camshaft is towards the control valve end of the pump.*

8. Position the right half of the pump, making certain that the dowel pins (No. 7, Fig. 53) enter the holes in the bushings.

> *NOTE: Dowel pins are not present in the new type pumps.*

9. Install the cap screws and tighten to 50-55 ft.-lbs., torque.

10. Install the valve retainer handle and tighten the cap screws to 50-55 ft.-lbs. torque.

11. Insert the first sealing washer (No. 9, Fig. 48) "O" ring (No. 8, Fig. 48) the pressure side bushing (No. 7, Fig. 48) and the second "O" ring (No. 6, Fig. 48) in the control valve bore of the pump.

12. Position a sealing washer (No. 5) inlet bushing (No. 3) and second sealing washer (No. 2, Fig. 48) on the inlet end (No. 11) of

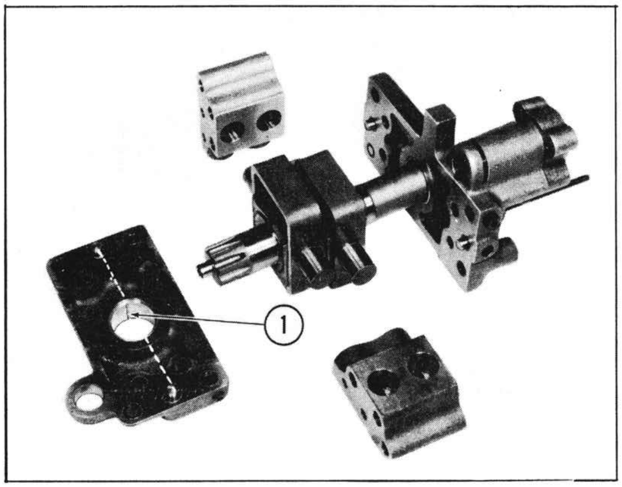

Fig. 61 — Sandwich Type Pump — Exploded View
1. Oil Groove

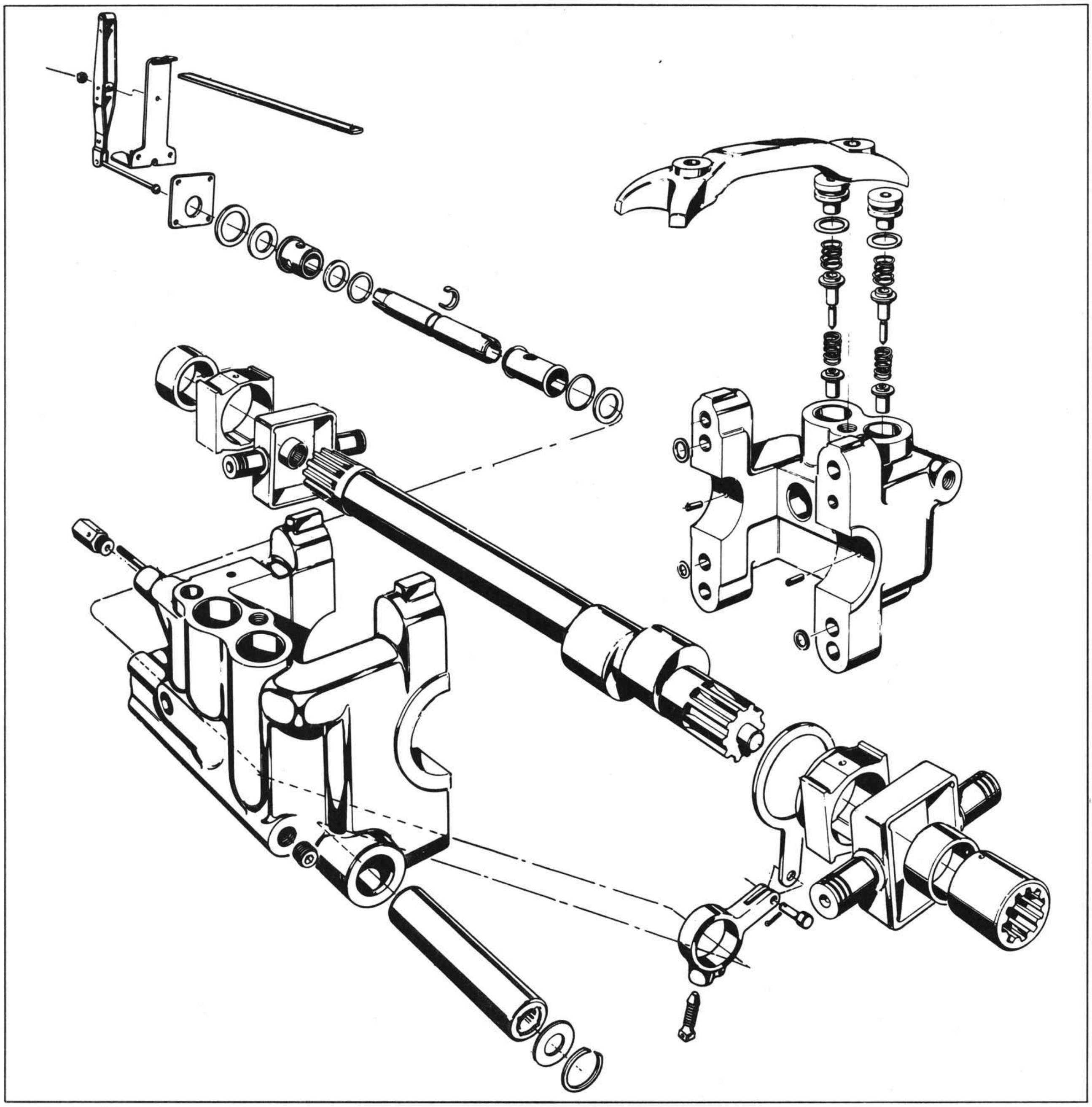

Fig. 62 — Hydraulic Pump — Old Type

the control valve (No. 10, Fig. 48) and carefully place the assembly in position.

13. Install the control valve washer (No. 1, Fig. 48), Plate (No. 3) and lever guide bracket (No. 2, Fig. 49) and tighten the cap screws.

14. Install the oscillator assembly, washer and snap ring.

15. Tighten the set screw and lock with wire.

16. Position the control valve lever assembly and turn the self-locking nut on until flush with the end of the adjusting bolt.

HYDRAULIC VALVE RESEATING TOOL

The hydraulic valve seat reseating tool, Number N-6007, may be used to reseat damaged valve seats in all hydraulic system pumps used in the MF, MH, F and TO 35, 40, 50, 65, 202 and 204 tractors, both present and previous production.

If the valve seats are not too badly damaged or worn several reseating operations may be performed if only enough metal is removed to "clean up" the upper seat in each bore. When the upper seat has been "cleaned up", the lower seat will be automatically reseated.

Using the Valve Seat Reseating Tool

1. Disassembly the pump and apply lubricating oil to the valve bores.

2. Place the pump body in a soft-jawed vise as shown in Fig. 60.

3. Carefull insert the reseating tool in the valve bore as shown in Fig. 60.

Do not drive or apply extreme force to bring the cutting edges (No. 2) into contact with the valve seats (Nos. 3, 4, Fig. 59). The amount of resistance encountered will vary from one pump to another because of the allowable manufacturing tolerances.

> *NOTE: If extreme resistance is encountered, it will normally be due to the pilot (No. 5) binding in the bore of the inlet valve seat (No. 4, Fig. 59). This binding occurs because the inlet seat has been severely beaten by hy-*

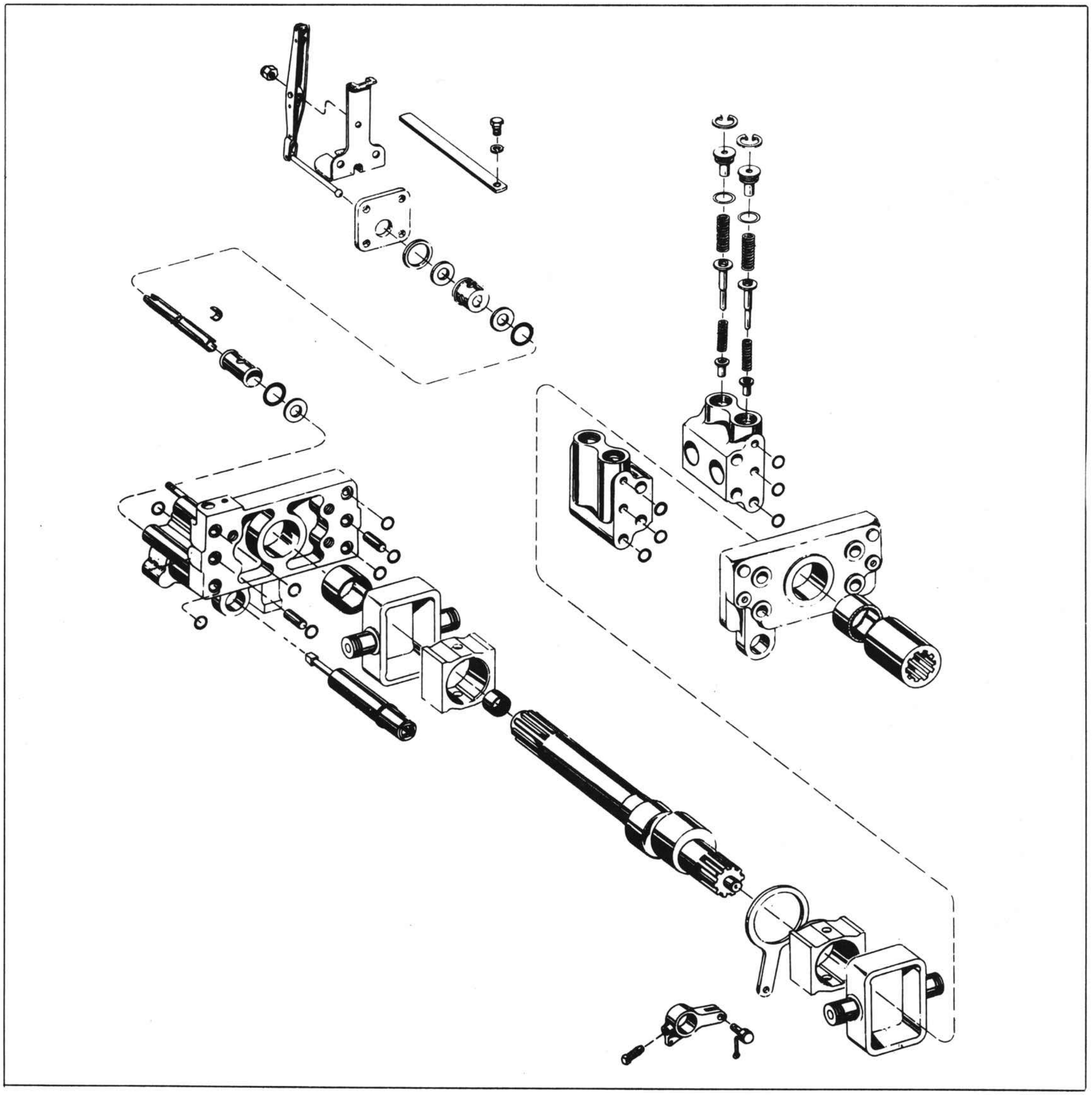

Fig. 63 – Hydraulic Pump – New Type

> *draulic force during prior pump operation. This closes the tolerances in the bore of the seat. If this condition exists, insert a tapered screw driver into the inlet valve bore and carefully rotate several times to clean away the protruding metal.*

4. Rotate the tool in a clock-wise direction. Exert a firm, steady sidewise and inward pressure at the same time as shown in Fig.60. The new seats will be properly aligned and refaced as a result of the tool being held true in the bore by the upper (No. 1) and lower (No. 5, Fig.59) piloting surfaces.

> *NOTE: Chattering of the valve seat will result if the tool is not held in constant with the valve seat. If the seat becomes chattered, insert the tool far enough to remove the high spots first. After high spots have been removed, completely insert the tool and finish reseating the valve seat.*

> *NOTE: Remove only enough metal to "clean up" the upper seat in each bore. Do not remove an excessive amount of metal.*

5. Examine the seat frequently. The seat surfaces should appear smooth and without grooves or checks in the metal. Further reseating may be necessary if the seats were severely grooved or damaged.

6. Clean pump bodies thoroughly with solvent and dry with compressed air. MAKE SURE THAT ALL OF THE METAL CUTTINGS AND RESIDUE LEFT BY THE RESEATING OPERATION ARE REMOVED FROM THE PUMP BODY.

> *NOTE: Upon close inspection, after the seats have been cleaned up, they may seem porous although smooth in overall appearance. This condition is no cause for concern since the inlet and outlet valves are a harder metal and will serve to polish the seating surface as they wear-in under hydraulic pressure.*

7. Always install new inlet valves and outlet valves in the pump body after it has been reseated. Check the valves and springs for magnetism as this may cause erratic action of the hydraulic system. Assemble the pump and install it in the tractor.

8. Clean up the reseating tool, oil, cover the cutters, and store in a clean place for future use. If the tool should become worn, or dull, it may be sent to Nuday Company, 17510 Wyoming, Detroit 21, Michigan for reconditioning.

> *CAUTION: The working life of this tool depends upon the care it receives. Do not drop or abuse the tool; the cutting edges are made of an extremely hard and brittle metal and will shatter when improperly handled. Refer to decal on tool shaft for further information.*

The hydraulic pump reseating tool N-6007 may be obtained through the Massey-Ferguson Branches or ordered directly from Nuday Company, 17510 Wyoming, Detroit 21, Michigan. Price of the tool is $33.80 F.O.B. Detroit.

Installing the Hydraulic Pump

1. Place the pump in position in the differential center housing.
2. Install the dowel pins on either side of the differential center housing.

> *NOTE: Notice that the dowel on the left side of the tractor fits loosely while the dowel on the right side fits very snug. Place the dowels in position but do not tighten them at this time.*

3. Install the PTO shaft as outlined in Group II, Section D, Part 1.
4. Fill the differential center housing with the correct oil to the proper level.
5. Start the engine and allow it to idle.

> *NOTE: With the dowels loose while the engine is idling, the pump automatically aligns itself with the PTO shaft.*

6. Tighten the right dowel first and then tighten the left dowel.
7. With the engine still at an idle, shift the PTO selection lever into the various selections available several times.

> *NOTE: If binding is present, and it is difficult to change the PTO selection, usually the pump will be out of alignment. Loosen the dowels and retighten while the engine is idling.*

8. Install the rear drive shaft and coupler after the engine has been stopped.

NOTE: Make sure that a cotter pin of of the proper diameter and length is installed in the rear drive shaft coupler.

9. Install the hydraulic lift cover. See Page 17.

10. Complete adjusting the hydraulic system as outlined on Page 8.

HYDRAULIC SYSTEM, DIFFERENTIAL AND TRANSMISSION LUBRICATION

The oil used in the hydraulic system is also used to lubricate the transmission and differential.

Capacity of these combined units is 8 U.S. (6-1/2 Imperial) gallons. Oil specifications are:

S.A.E. 90 for temperatures above 50°F.
S.A.E. 80 for temperatures below 50°F.

Additional oil must be added if the requirements of an external hydraulic system are greater than 1-1/2 gallons. This additional oil must be drained from the housing if the external hydraulic system is disconnected.

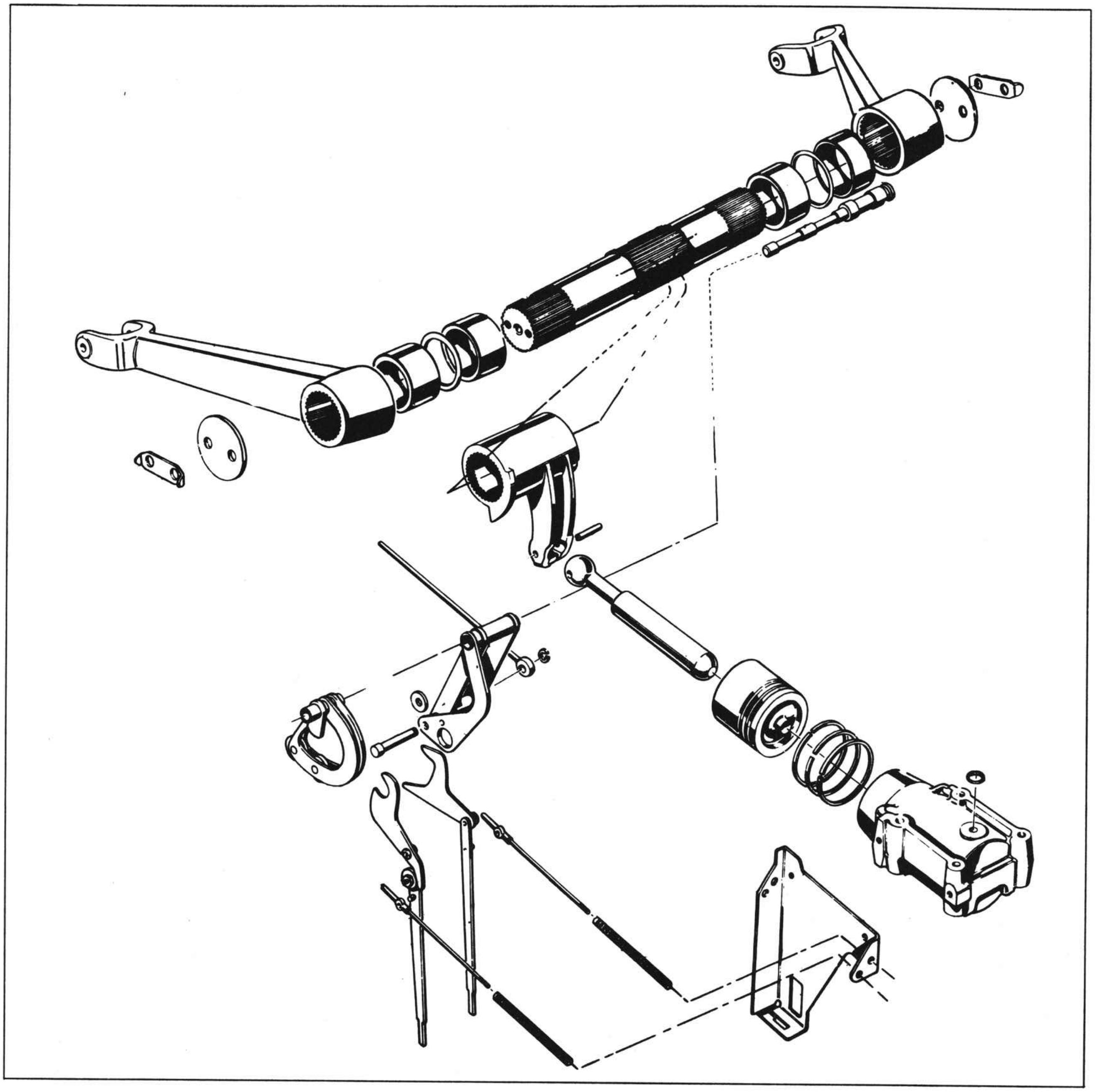

Fig. 64 – Lift Assembly

HYDRAULIC SYSTEM SPECIFICATIONS

SPRING TESTING SPECIFICATIONS

Outlet Valve Spring (180 928 M1)	
Ounces Pressure @ 13/16 inch	22 to 26 Ounces
Inlet Valve Spring (180 927 M1)	
Ounces Pressure @ 1 inch	18 to 22 Ounces
Control Valve Spring (180 940 M1)	
Ounces Pressure @ 3-7/16 inch	48 to 56 Ounces

CAM BLOCKS (180 924 M1 AND 180 925 M1)

Inside Diameter	2.000 - 2.001 inch
Maximum Inside Diameter	2.005 inch
Distance Across Parallel Faces	2.317 - 2.320 inch
Minimum Distance Across Parallel Faces	2.314 inch

HYDRAULIC LIFT CYLINDER (184 442 M1)

Cylinder Bore Diameter	2.9995 - 3.0010 inch

HYDRAULIC LIFT CYLINDER (180 967 M1)

Cylinder Bore Diameter	2.4995 - 2.5010 inch

HYDRAULIC PUMP BODY (180 919 M91)

Cylinder Bore Diameter	0.802 - 0.803 inch
Maximum Cylinder Bore Diameter	0.804 inch

PISTON ASSEMBLY (181 043 M1)

Distance Between Parallel Faces		2.322 - 2.325 inch
Maximum Distance Between Parallel Faces		2.328 inch
Piston Diameter		0.8005 - 0.8010 inch
Minimum Piston Diameter		0.7995 inch
Piston Ring Gap	Maximum	0.0075 inch
	Minimum	0.0025 inch

Piston Ring Gap to be measured with ring inserted in a new cylinder

CAMSHAFT (180 922 M91)

Outside Diameter of Cams	1.996 - 1.997 inch
Minimum Outside Diameter of Cams	1.993 inch
Diameter of Camshaft Bearing Journals	1.3745 - 1.3750 inch

CAMSHAFT BEARING (Bronze) (181 046 M1)

Outside Diameter	1.749 - 1.750 inch
Inside Diameter	1.3770 - 1.3775 inch
Maximum Inside Diameter	1.3785 inch

VALVE CHAMBER BODY (184 471 M1)

Cylinder Bore Diameter	0.9140 - 0.9150 inch
Maximum Cylinder Bore Diameter	0.9155 inch

PISTON ASSEMBLY (184 470 M1)

Distance Between Parallel Faces		2.322 - 2.325 inch
Maximum Distance Between Parallel Faces		2.328 inch
Piston Diameter		0.9125 - 0.9130 inch
Minimum Piston Diameter		0.9120 inch
Piston Ring Cap	Maximum	0.0075 inch
	Maximum	0.0025 inch

Piston Ring Gap to be measured with ring inserted in a new cylinder

CAMSHAFT (181 993 M91)

Outside Diameter of Cams	1.996 - 1.997 inch
Minimum Outside Diameter of Cams	1.993 inch
Diameter of Camshaft Bearing Journals	1.3745 - 1.3750 inch

PUMP BODY (182 005 M91 AND 182 006 M91)

Camshaft Bearing Bore Diameter	1.6198 - 1.6208 inch

CAMSHAFT BEARING (Needle) (195 950 M1)

Outside Diameter	1.6200 - 1.6205 inch

CAMSHAFT BEARING (Bronze) (195 949 M1)

Outside Diameter	1.6210 - 1.6215 inch
Inside Diameter	1.3775 - 1.3780 inch
Maximum Inside Diameter	1.3790 inch